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**Experiences of successful physical activity maintenance among adults with Type 2
diabetes: A theory-based qualitative study**

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Abstract

Objective: Approximately 70% of adults with type 2 diabetes (T2D) fail to achieve the 150 minutes of weekly physical activity (PA) recommended for self-management. Interventions to promote PA adoption in T2D rarely achieve stable maintenance. Analysis of lived experiences of adults with T2D who have successfully transitioned to long-term PA maintenance can build understanding of factors influencing long-term maintenance.

Design: Semi-structured interviews were conducted among 18 adults with T2D who had transitioned to a lifestyle incorporating maintenance of recommended PA. Interview topics were informed by the three phases of the 'Multi-Process Action Control' (M-PAC) Framework, and explored attitudes, beliefs and experiences relating to PA decision, adoption and the transition to stable maintenance. Transcripts were thematically analysed.

Findings: Seven themes emerged. Results variously showed that negative affect engendered by T2D diagnosis and inspiration from peers influenced intention formation, and that setting easy, fun goals, and experiencing biopsychosocial gains were important to behaviour adoption. PA maintenance was regulated by habit, expectations of positive affect, and a new sense of identity.

Conclusion: Phase-based frameworks can help understand how regulation of behaviour evolves over time. PA promotion strategies for inactive adults with T2D should be phase-tailored, to help people transition from intentions to maintenance.

Keywords: physical activity, behaviour change, behaviour maintenance, type 2 diabetes, thematic analysis, Multi-Process Action Control Framework, dual process theories of behaviour change

Introduction

Type 2 diabetes (T2D) is a long-term condition that is considered a public health crisis (Herath et al., 2015). Globally, there are an estimated 450 million adults diagnosed with T2D, with a further 51% rise in incidence predicted by 2045 (Aguayo-Mazzucato et al., 2018). T2D is believed to progress through stages, characterized by increasing levels of glucose in the blood (Murray et al., 2018). Uncontrolled, this can lead to damage to blood vessels and nerves, presenting serious risks to health, including vision loss, kidney disease, myocardial infarction, amputations, stroke and death (Thompson et al., 2014). To allay disease progression, biomedical interventions to control hyperglycemia are often prescribed (American Diabetes Association, 2017), however approximately 50% of people living with T2D fail to achieve adequate glycemic control (Ali et al., 2012; Ford, 2011). A range of non-biomedical condition management options related to health behaviours, such as regular physical activity (PA), is also known to help control the disease (Colberg et al., 2016). Following the recommendations of engaging in at least 150 minutes of moderate to vigorous physical activity (MVPA) per week can promote management of core treatment goals (American Diabetes Association, 2015), reduce reliance on hyperglycemic medication and potentially slow, halt, or even reverse T2D progression (Colberg et al., 2016). Yet, it is estimated that 60 to 70 per cent of T2D adults do not meet PA recommendations (Balducci et al., 2019). Effective intervention to promote PA within this population is urgently required.

Despite the benefits of increased PA, the optimal strategy to support people with T2D to achieve and sustain a physically active life has yet to be found (Balducci et al., 2019). Interventions to promote PA in inactive adults with T2D typically meet with limited success, and even when PA increases are achieved, PA levels often wane or return to baseline levels after the intervention is withdrawn (McEwan et al., 2020). The limited success of interventions to promote PA maintenance in inactive adults with T2D is thought to be due to

three overarching shortfalls in intervention design (Dunton, 2017). Firstly, interventions, though often theory-based, have generally been informed by models of behaviour that emphasise factors relevant to the initiation of behaviour, neglecting to consider change over time and the critical challenge of promoting long-term adherence to a PA regime (Avraham et al., 2016). PA intentions are created, yet these intentions are not translated into sustained behaviour: an ‘intention-behaviour gap’ occurs (Papies, 2017). Secondly, and relatedly, these models tend to embrace mainly reflective factors such as expected outcomes, self-efficacy and intention to engage in the behaviour (Papies, 2017). In so doing, they fail to acknowledge intuitive, impulsive automatic processes, such as affective judgments and expectations, habit and identity, which are increasingly understood to influence behavioural decision-making in different ways, across time, on the trajectory from initial intention to stable maintenance of behaviour (Rhodes, 2017). Thirdly, PA interventions targeting adults with long-term conditions have tended to focus on rational clinical motives and outcomes, such as weight loss and glycemic control, often omitting to consider the person beyond the pathology, and that other factors beyond clinical improvements, may be more conducive to inducing PA motivation, initiation and long-term maintenance (Castonguay et al., 2018).

Research into PA in adults with T2D, has also predominantly relied on quantitative methods, focussing on statistical explanations and prediction of PA engagement (Walker et al., 2018). When the PA maintenance stories of adults with T2D are primarily stories of barriers and non-compliance with recommendations (Cartagena et al., 2021), the statistical conclusions from quantitative research inevitably fail to capture the success that some achieve. Qualitative study of adults with T2D who have bucked the well-evidenced trend and made a successful transition to sustained PA at recommended levels offers the opportunity to understand the experiences, beliefs and values of individuals as they adopt and maintain new health behaviours. This in turn may aid the understanding, prediction and promotion of

sustained regular PA engagement in physically inactive adults with T2D (Holahan et al., 2017; Walker et al., 2018).

Applying theoretical frameworks to collect and analyse qualitative data can help ensure coverage of the full breadth of influences on experiences. The Multi-Process Action Control (M-PAC) Framework (Rhodes, 2017) was designed to facilitate focus on the factors and processes which influence the evolution of behavioural intention into behaviour adoption, and in turn, into long-term behaviour maintenance. The framework synthesises and organises existing theory and research related to determinants of PA into three 'layers', distinguishing between correlates of PA intention, adoption and maintenance (R. E. Rhodes & Yao, 2015). The intention formation phase is grounded in reflective processes: here motivation is theorized to come from conscious deliberation about aspects of the change (such as instrumental attitude, perceived capability and perceived opportunity). Behaviour adoption is theorized to be influenced by mainly regulatory processes: the new behaviour is consciously managed through explicit tactics aiming to translate intentions into behaviour (such as goal-setting, self-monitoring and forming implementation intentions). Behaviour maintenance, however, is theorized to unfold with minimal effort or conscious aforethought. The need for effortful reflective motivation and regulation recedes, and the behaviour is controlled primarily by automatic processes, related to affect, habit and identity (North, 2012; Rhodes et al., 2021). A systematic review of research into PA grounded in the M-PAC framework showed its constructs to be predictive of physical activity in a variety of populations (e.g., older adults, cancer survivors), and studies have shown overall support for the proposed three-phased structure (Rhodes et al., 2021).

The present study employed qualitative methods, guided by the M-PAC Framework (Rhodes, 2017), to capture the experiences of adults with T2D who have successfully transitioned to a lifestyle incorporating maintenance of recommended levels of PA. We

sought to capture theoretically coherent explanations for PA and identify factors influencing the decision to be active, initial attempts at adoption, and continued maintenance. Our research question was: *How do people with T2D, who have successfully adopted and maintained regular PA at recommended levels, experience the journey from diagnosis to PA intention, adoption and eventual maintenance, and which factors appear to influence the transition between these phases?* Understanding experiences of PA intention-adoption-maintenance success among adults with T2D will help us to better predict and promote PA in adults with T2D and other long-term conditions (LTCs).

Methods

Participants

Participants were recruited using convenience sampling methods from international T2D online social networks and international PA social networks between October 2019 and February 2020. Eighteen participants were recruited, in accordance with theme saturation recommendations for Thematic Analysis of this type (Braun & Clarke, 2016). Participants were required to have a formal T2D diagnosis and to have engaged in 150 minutes of MVPA per typical week for at least six months. Six months was chosen as a threshold in line with PA maintenance literature (Fjeldsoe et al., 2011; Prochaska & Velicer, 1997). Participants were native English speakers from UK, USA, Australia and Canada. People with diabetes other than T2, or with a comorbid advanced or terminal condition or known severe mental illness were ineligible. Ten participants were male and eight female (age range 41-76 years, mean 56 years; time since diagnosis range 0.5 – 22 years, mean 10.5 years). No incentives for participation were offered.

Procedure

Permission to approach users of online T2D- and PA social networks was sought from group administrators in October 2019. The selected networks were closed online groups, each

of between 2 000-35 000 members, who communicated in English. Where permission was granted, an invitation to participate outlining the study and eligibility criteria was posted. Eligible willing participants gave electronic consent and an online one-to-one interview was scheduled. Semi-structured interviews were conducted via an online video call. Participants were interviewed individually, and encouraged to talk freely, with prompts used where necessary to facilitate further discussion and exploration of interesting themes. Following the interview, participants completed a brief demographic questionnaire. Interviews lasted between 45 and 65 minutes. The interviews were audio recorded with permission, and transcribed verbatim to Word. The study was approved by the King's College London Research Ethics Committee (LRS-18/19-12012).

Interview schedule

The interview schedule was aligned with the three phases of the Multi-Process Action Control (M-PAC) Framework (Rhodes, 2017; Rhodes *et al.*, 2019). The schedule was informed by the M-PAC and an extant review of concepts relating to behaviour maintenance (Kwasnicka *et al.*, 2016), to ensure inclusive coverage of potential theoretically-guided explanations for the transition from intention to maintenance. Interviews focused on thoughts and beliefs about which factors were influential at the three stages on the PA intention-adoption-maintenance journey.

Researcher positionality

The primary researcher (JB) is a PhD student in Psychology who has been studying PA behaviour change and maintenance for some years, using qualitative and quantitative research to observe, predict and explain PA. The research was supervised by BG, a social psychologist with extensive qualitative and quantitative research experience, and JC, a psychologist with an interest in LTC self-management. At the time the study was conducted, JB, BG and JC spent many sedentary hours per day at a computer. JB adhered to PA guidelines by running,

or going to the gym six days a week, whilst BG and JC strived to meet recommendations but were largely unsuccessful in maintaining regular PA. Neither JB, BG or JC have diabetes. The broader purpose of the study was to identify factors that could inform a follow-up, intensive longitudinal study tracking factors relating to PA maintenance over time in people with T2D attempting to change PA behaviour.

Analysis

Analysis was theory-informed but driven by the data. Verbatim transcripts were analysed by JB using Thematic Analysis (TA; Frith & Gleeson, 2008; Braun & Clarke, 2006; Braun & Clarke, 2016), with the M-PAC framework (Rhodes et al., 2019) providing a structure for the analysis. The process commenced with immersion and familiarization with the data, generation of initial codes of meaning in the text, searching for patterns and themes, reviewing themes, and then defining and naming themes (Braun & Clarke, 2006, 2016; Frith & Gleeson, 2004). Themes captured key strands of perceived determinants of physical activity from decision to long-term maintenance and were then organized within the three phases of the M-PAC framework: PA intention formation, PA adoption and PA maintenance. Codes, emergent themes, insights and write-up were iteratively discussed with, and confirmed to be a valid representation of the data by a senior qualitative researcher (BG) (Smith & McGannon, 2018).

Qualitative methodologists have called for researchers to declare the fundamental purpose and assumptions of analysis (McGannon et al., 2021). Our aim was to conceptually describe participants' experiences, and perceived influences on those experiences. Our analysis adopted positions of relativist ontology, which assumes that participants' experiences of reality are dependent on their subjective interpretation and knowledge (Braun & Clarke, 2013), and phenomenological epistemology, which assumes that participants can reliably reflect on those experiences (Braun & Clarke, 2006; Braun et al., 2016).

Findings

Seven themes were identified. Of these, two (the affect catalyst; inspiration and guidance from others with T2D) were identified as influential in the decision to initiate PA. Two themes (setting achievable, behaviour-centric goals; monitoring short-term gains) were identified as key in PA adoption. Three themes (motivated by affect; regulated by habit; sustained by identity, connection and belonging) emerged as influencing sustained PA maintenance.

1: Intention Formation Phase

Theme 1a: "I did it out of fear": The affect catalyst

Learning from a healthcare professional about the chronic and incurable nature of T2D, and its progressive complications created powerful negative affective responses in most participants. Participants attended often to the most severe T2D progression consequences, such as amputations, heart disease and death. Feelings of fear, grief, powerlessness and despair were reported. These negative affective responses were perceived to catalyse the decision to take action: some were inspired from the moment of diagnosis; others later when they learned more about potential ramifications. Additionally, participants reported feeling shame and embarrassment about their own role in developing the condition. The negative affective response to diagnosis pushed participants towards a decisional tipping point, characterised by a strong need to change, to take back control of their health and avert the consequences of diabetes progression.

"I was terrified of getting my foot chopped off. I thought: 'Oof, this is really really serious what can happen there!' Chronic, progressive disease that leads to heart attack, stroke, amputations, and blindness! Once I read that, that was it, and I thought: 'I need to do something about this!'" (male [M], participant 13 [P13]).

For many, the tipping point was triggered by feelings of anger and rage activated by learning from the healthcare professional that T2D was a long-term condition which would worsen with time and that a lifetime of daily medication was the only solution. They reported not wanting to ‘give in’ (F, P3) to this by letting T2D and medication dictate how their life would play out, and instead wished to fight back against diabetes and the need for medication. Regular PA and a healthy diet were seen as natural alternatives to medication, so were used as weapons to empower self-management.

“The first thing the diabetic nurse said was: ‘right, I will put you on metformin’. I said, ‘OK’, but I then said, ‘No!’. And I [have] successfully since managed [to control my diabetes] with just diet and exercise. [...] Going on medication is like giving into it. It’s an ongoing battle with my diabetic nurse around medication.” (F, P3)

Theme 1b: “If they can do it, so can I!” Inspiration and guidance from others with T2D

Inspiration leading to the decision to become physically active was found in the success stories and strategies of other adults with T2D who had adopted a healthier lifestyle incorporating regular PA. Others’ successes provided inspiration and an apparent roadmap to success: participants were excited to learn that freedom from medication and control over, or even reversal of, diabetes was possible by adopting PA with a healthier diet. Advice of ‘real people’ (P10) in a similar situation seen on TV or in real- and online peer groups gave shape to their intention to change, and was more strongly valued than that of HCPs or other experts, who participants reported to have either not given PA advice or given advice contrary to that shared in fellow patients’ stories. The feeling that ‘*if they can do it, so can I!*’ (M, P5) heightened their belief in their own capability to change, and empowered participants in the decision to embark upon a physical activity lifestyle change.

“The BBC showed a documentary called Fixing Dad... Here’s this guy, a bit older than me, type 2 diabetic ... he changed the way he eats and he exercises more. And his diabetes is put into remission. And I was like. ‘Oh? Well! If he can do it, I can do it!’ And that is what started my journey.” (M, P13)

As well as inspiration, peers within social networks, both online and off were seen as influential to the initial decision in other ways; especially in galvanizing resolve to launch the PA lifestyle change project. The knowledge gained from peers about what was achievable in terms of PA and diabetes control, fed into and reinforced the decision to make a change. Beyond knowledge about the possibility of change, and different ways to make change more realistic, peers provided other types of support at the decision stage. Social support, often accessed via joining physical activity clubs or online or offline programmes, was reported as helpful in many ways, providing guidance about how to get started, a feeling of belonging and common purpose, a source of encouragement and advice, and a sense of commitment to others. With knowledge, strategies and support from peer support networks, individuals were able to better define their intentions and ready themselves to mobilize resources for change.

“I think it is really difficult to do it [change to a physical active lifestyle] on your own, but if you can get a group of people together with that same core goal, you become reliant on each other; you know someone is waiting for you to go and do it at the same time, so you have to turn up. If it’s a little bit wet and cold, I’ll just sit and the sofa and watch telly. Whereas, if it’s wet and cold, but three of my mates are standing there waiting for me to go for a run, I have to go. Building the interdependency is key.” (M, P2)

2: The Behaviour Adoption Phase

Theme 2a: “Make it easy, make it fun”: Setting achievable behaviour-centric goals

Participants typically reported that at the outset, though they had ambitious overarching goals including becoming active, getting fit, losing weight and taking control of their diabetes, they knew there was a risk that if the goals were too ambitious, success would not necessarily be experienced before discouragement set in. Setting and successfully meeting modest initial PA goals, such as ‘going for a walk several times a week’ (P2), or ‘jogging a kilometre without stopping’ (P1) enabled initiation without becoming overwhelmed.

“It has got to be gradual targets, gradual results.” (M, P7)

“One day at a time. Long-term goals can be over-facing. I am doing this today.” (M, P8)

“It’s the small hinges that swing big doors.” (M, P10)

Participants believed that the likelihood of successful engagement would be increased if they chose physical activities that they found enjoyable and avoided those that they did not find enjoyable. Trial and error were used at first to discover suitable forms of PA.

“I said: ‘Alright let’s try this exercise, and if it sucks, I just won’t do it again!’ I started to look at the gym like one big playground. I imagine I am 7 years old again and thinking: ‘lets just play!’ And not everything on a playground are you going to want to play with. Some things are going to be cool and some things are going to suck. Whatever sucks just don’t do it. And whatever is fun, do it again. And then you can become proficient at it.” (M, P10)

Theme 2b : “If you succeed, you will carry on.” Monitoring short-term gains

Continued mobilization of resources was fuelled by a variety of short-term rewards reaped from PA engagement. Each reward reportedly strengthened the likelihood of a remobilization of resources for subsequent engagement. In the initial stages of PA engagement, participants were very conscious of rational outcomes of engaging in PA: rewards were monitored keenly, and appreciated when experienced.

“If you succeed, you will carry on doing it. If you don’t, you will quit.” (M, P7)

Short-term biological gains included early improvements in blood sugar levels. Participants monitoring blood glucose noticed that engagement in PA had measurable effects on their subsequent blood glucose levels. Even when diet was not optimally controlled, moderate-to-vigorous PA, such as a 30-minute walk, cycle or jog would translate into noticeable change on the glucometer. This was an unexpected and very welcome benefit of PA for many, who then decided to use PA as a daily tool to regulate blood glucose.

“I started to do more exercise, and I found that my blood sugar was getting lower the more exercise I did. In the hospital, I ended up walking 4 kilometres every day around the wards. I kept my blood sugar down even with no medication – such an eye-opener!” (M, P12)

A variety of psychological and affective gains were experienced soon after participants began to engage in PA. Positive psychological rewards were monitored and included stress reduction, feelings of pride about ‘being good’, increased positive affect, and mood elevation.

Enjoyment during and after PA was also linked to pride in performance, in personal improvements or completing events. The purpose and pleasure of competing against oneself (using tracking technology and personal goals) and others (in real life and on social PA media) was integral to enjoyment. Sometimes the performance aim was to win but most often, merely engaging in and completing the behaviour was a form of motivation.

“But at the finish [of the parkrun 5km] – either when you think you have had a good run or you get that lovely smug feeling of ‘Great, I’ve been out. Now, it’s 10 o’clock on a Saturday morning and I have already done 8500 steps, 5K! I feel so good about myself!’” (F, P3)

“And I started very soon to see the benefits of the stress relief. In my job, there was a fair amount of stress, but the mood elevation and the sense of control that I was making a difference was really very powerful.” (M, P5)

3: The Behaviour Maintenance Phase

Theme 3a: “It went from being something I did out of duty to something I did for fun.” Affect-based motivation

Participants recalled that after some weeks or months of regular PA engagement, and a gradual aggregation of biological, psychological, affective, and social gains, they perceived a shift in the way they thought about, and, importantly, felt about it. The experience of pleasure and enjoyment during PA engagement, and as a result, expectations of pleasure related to PA was reported as a primary motivator for a transition from initial adoption to regular PA maintenance. PA engagement transitioned from being something they felt they ought to do, to being something they enjoyed and so wanted to do repeatedly. The necessity to mobilize conscious, effortful processes to motivate the behaviour receded as unconscious processes came to be associated with PA. A network of various interacting factors related to monitoring the activity and its outcomes, and feeling satisfaction with both, incentivized continued PA engagement, the simplest of which was the immediate feeling of well-being reported from being active for its own sake, and from being out in the fresh air and enjoying a connection with nature.

“The joy, the actual psychological aspect of the biking – being out in the air is genuinely motivating. I just love being out in the air.” (M, P5)

Elevated mood and affect experienced after PA sessions was perceived as integral to PA maintenance. The expectation of feeling better after PA compelled regular, often daily, engagement. Many believed that their long-term maintenance of PA was to a large extent driven by considerations of immediate or short-term emotional gains on an event-based or daily basis. Happiness, fun, general mood elevation and even joy were reported as experienced in connection with PA, either during sessions, immediately after, for the rest of the day, or all three. As well as being valued for promoting positive affect, PA was thought to reduce negative affect. Participants came to use PA to help regulate mental well-being, relieving current or expected emotional needs, such as stress, irritability and low mood on a daily, weekly, or ongoing basis.

“I think diabetes has underlying mood issues, anxieties, stress, depression and all that and I feel like exercise has really helped me on that. My focus, my concentration, my mood. After exercise for an hour - it is like my medication.” (F, P17)

“There are two things [that I like about exercising]: my endorphins are through the roof, I don't give a dang about anything in the universe, I am happy, I am stoked, we can talk about anything, everybody is my best friend. So now it is like, hey, I have this phenomenal release, my energy is up, it sets the pace for the rest of the day!” (M, P10)

There was furthermore a perception that the rewards of PA interacted with each other, to produce a result that was greater than the sum of parts. The mood elevation of PA, for example, was perceived as heightening control of food intake; weight loss enabled better performance in PA goals, and improved glycemic control. Awareness of the multiplicity of benefits of PA and their mutual influence contributed to its perceived value. Fear of loss of these many accrued benefits was also a factor they believed contributed towards their ongoing maintenance. These myriad new pleasurable and otherwise positive associations with regular PA glued the new behaviour into place, and automatically motivated continued engagement.

“I know running helps my mental health. [if I stop running] I start to feel substandard and I start to put weight back on. Last year when I was injured and wasn’t running, my weight went back up. And my HbA1c went up. And it’s all tied in. If I stop running, my diabetes will get worse.” (F, P3)

“I talk that I would never leave out the exercise, because truly that was a catalyst for me, It is a sense of joy. It is a sense of something I would not want to be without. Certainly you can achieve the remission without it, there is no doubt about that – but for me, sustaining this – I am just not going to go back to a sedentary – you know I just have no motivation for it, I enjoy the riding so much.” (M, P5)

Theme 3b: “Saturday is parkrun day” – Regulated by habit

PA engagement routines, mostly time-regulated, scheduled on a repeating weekly or daily basis, were considered important in the transition to maintenance. Many reported how they relied on and deferred to their routines, so that their PA engagement became to a large extent pre-determined by the day of the week and time of day, relieving them of the burden of ongoing decision-making and planning that was necessary at the decision and adoption phase. Regulation of PA behaviour became less and less effortful, and participants reached a point where the day of the week and time of day was an automatic cue for physical activity.

“I tend to carbon copy my days one over the other quite religiously. Around noon I get on my bike and do my 30 minutes. I aim to elevate my heart level as quickly as possible and keep it up there for 25 to 30 minutes. I do generally seven days a week, and sometimes six.” (M, P9)

“Saturday is Parkrun. Running club is Thursday evening, and I always try to do something else too – either Monday or Tuesday, depending on what other people might be available to do.” (F, P1)

Habits and sustaining patterns of activity were considered important in preventing relapse. Environment, daily commitments, and other contextual factors were believed to influence their PA habits, in that they became automatic cues for PA engagement. Concern was voiced about being able to maintain PA engagement when situation or context changed, such as on vacation or business trips, or when weather or other environmental conditions disrupted routines. New and effortful self-regulation strategies were required in these cases.

“It’s easy if you are active, to stay active and to increase your activity. Keep at it so it becomes a habit rather than something you have to make an effort to do.” (M, P2)

“I’ve been really getting really excited about doing the exercise, and it feels like, if I don’t, something is missing... I am going on a cruise around New Zealand for our 50th wedding anniversary, so I am

planning what to do, and someone has said that there are walking tracks around the ship and a gym, so I will be okay; I have got myself all planned to do these things when we are away.” (F, P6)

Theme 3c: “I am a runner”. Identity, connection and belonging

A final theme which was identified as the nail in the coffin of a sedentary lifestyle, and a trusted determinant of ongoing PA maintenance, was a perceived shift in identity. After some time of regular PA maintenance, appreciating its outcomes, and transitioning to more pleasure/ affect-based motivation, and habit-driven regulation, participants explained how they began to feel that being active had become an integral and valued part of their sense of self, and that they would not ‘be themselves’ without PA. Many valued their physically active identity highly and were proud to present and profile themselves as physically active. The physically active identity was then perceived as both outcome and determinant of ongoing maintenance.

“I identify very very much as a runner. My facebook profile these days has only got me in running tops (laughing). In the old days, I would just put a leaf or something as my profile picture – it mostly didn’t even have me in it. But these days, it’s just always got me looking sweaty (laughing) after finishing a run.” (F, P1)

Connection and belonging to a group was key in the identity shift. For most participants, there was a significant social aspect to their physically active life; it afforded many opportunities to enjoy new relationships, from simple group membership camaraderie, to lasting friendships. Social connections formed around PA were perceived as contributing to ongoing PA maintenance in many ways, providing accountability, knowledge, inspiration, encouragement and support. The intrinsic hedonic pleasure of social connection, friendships and belonging to physical activity groups was reported as contributing strongly to the continued physical activity habit.

“It’s the community that makes it great, because you see people going through the same struggle, and you get a lot from them and give to them too. [...] I think this idea, this ability to be part of a community is very very powerful.” (M, P5)

Discussion

This study adopted a phase-based theoretical framework to understand lived experiences of adults with T2D who have successfully translated PA intentions into long-term PA maintenance. Participants reported being catalysed to act by a strong negative affective response to diagnosis, which fuelled an intention to change. Success stories of peer role models who had controlled or reversed diabetes by adopting a healthy lifestyle provided inspiration and guidance, influencing a belief that engaging in PA could markedly improve T2D management, and showing them how. Setting achievable, fun, behaviour-centric (as opposed to outcome-centric) goals was key in the facilitation of PA adoption, and the experience of a variety of early short-term outcome gains, including measurable reductions in hyperglycemia, and feelings of pride for achieving goals, were considered key in promoting repeat engagement. A virtuous and dynamic cycle of PA behaviour, outcome gains and incentives steadily developed and expanded, encompassing biopsychosocial rewards reaped from being active and meeting people offline and on in connection with PA. Habit, pleasure and a new active sense of identity, connection and belonging to a PA community were considered central factors influencing ongoing maintenance.

Findings showed that factors influencing the formation of an intention to be active were firstly an affect-based catalyst which was perceived as energizing what followed. In the current study, participants all reported being shocked by their T2D diagnosis, and recalled this having added to their conviction to take action. This echoes research showing that negative emotional responses to a long-term condition diagnosis can create a 'teachable moment' (Demark-Wahnefried et al., 2005; Kearney & O'Sullivan, 2003): individuals who are strongly emotionally impacted by diagnosis are more likely to form an intention to act on behaviour change advice than those who are not (Castonguay, Miquelon, & Boudreau, 2018). Inspiration and guidance from peers with T2D were also strongly associated with the

formation of an intention to be more active. Social influences have been found to correlate with successful physical activity behaviour change in adults with T2D (Cradock et al., 2017), and findings suggested that one mechanism by which such factors may influence maintenance is by generating vicarious mastery experiences, which can boost self-efficacy (Bandura et al., 1977). As the M-PAC predicts, both automatic processes (avoiding displeasure) and reflective processes were involved in the formation of an intention to be physically active in these adults with T2D. These findings indicate that healthcare professionals might gainfully deploy the negative affect triggered by diagnosis and provide a brief PA intervention at this 'teachable moment'. It is important for interventions to be delivered at this critical time of the diagnosis, which might well harness negative affect and the realization of the need to act to avoid progression and worse outcomes. Since other adults with T2D have been shown to be more credible sources of information about T2D, HCPs might also profitably embrace social prescription (Ogden, 2018), signposting patients to exercise clubs and/or T2D support groups where they can meet adults with the same diagnosis and challenges. Additionally, patient success stories could be showcased to provide inspiration and guidance, and to enhance self-efficacy at or around the time of diagnosis.

Most PA behaviour change research is temporally-focussed around adoption of the new behaviour, and as such, there is much evidential support for the themes extracted relating to the PA adoption phase of the M-PAC framework (Avery et al., 2012). Goal setting has been seen as a core correlate of successful PA adoption in non-clinical and clinical populations (Greaves et al., 2011). Some theorists have proposed a distinction between PA outcome (or instrumental) goals (e.g., 'I will lose 7 pounds'), and PA behavioural (or experiential) goals (e.g., 'I will walk briskly around the lake with my friend'). Evidence indicates that PA goals related to behavioural experience are more likely to be met, and this may be key in promoting continued engagement (Fishbach & Choi, 2012). PA outcome goals, however, such as weight

loss, may take time to materialize and individuals may therefore be prone to disengage from the behaviour should the stated goals not materialize before motivation atrophies (R. E. Rhodes, McEwan, et al., 2019). This appeared as key to the early stages of adoption: though participants clearly wanted results, and to achieve physical transformation, such as weight loss, and other health benefits from becoming active, they focussed their initial goals around the PA activity itself (e.g. that it should be fun, and how long they should be active), and in this way, were able to feel successful even in the absence of measurable outcome gains, such as weight loss (R. E. Rhodes, 2017). Behaviour-centric goal-setting provided an inroad into initial PA engagement, and also into repeated PA engagement, which many considered crucial in gaining momentum on the journey. Advice delivered by healthcare professionals about setting realistic short-term behaviour-centric goals (as opposed to longer-term instrumental goals like weight loss) could be potentially effective in promoting a sustainable physically active life for people with T2D.

Monitoring of outcomes revealed short-term gains. Participants reported post-exercise reduction in hyperglycemia, which was highly motivating for continued engagement. Success achieved in relation to early behavioural goals has been shown to be predictive of continued maintenance (Rothman et al., 2004). Given that reduction in blood glucose levels is the primary treatment goal in T2D management, this outcome was particularly rewarding and motivating in this population. Since a widely-cited barrier to sustained PA engagement is lack of measurable or otherwise tangible benefits (Knittle et al., 2018), the glycoregulatory gains of PA for adults should be communicated by healthcare professionals to T2D patients. Brief, simple prescription of PA by the diabetes care team accompanied by the promise of immediate improvements in blood sugar might therefore be effective. Outcomes can, furthermore, be easily monitored with a 24-hour glucose monitor, or daily post-prandial glucose measurements.

When participants were asked about factors influencing ongoing maintenance, three key themes emerged. Many reported that they had formed PA habits, and that these helped sustain maintenance. Behavioural regulation during maintenance was perceived as more automatic, occurring in the same way, almost as default at certain times of day on specific, or all, days of the week. PA arrangements with fixed start times would only be missed under exceptional circumstances. Routinization of PA engagement is well evidenced as one route to sustained maintenance: as behaviour becomes habitual, the importance of reflective effortful regulation of PA recedes, and PA engagement, and the behaviours necessary to ensure it is carried through (such as getting ready, driving to the club) are triggered ‘automatically’ (Gardner, 2015). Furthermore, when the behaviour becomes sustained by habit, the habitual behaviours can continue even if initial motivation starts to erode (Gardner et al., 2020). Yet, habit was not the only factor considered as contributing to PA maintenance. As PA engagement patterns became established, new motives for PA emerged, connected to the ongoing experience and outcomes of PA engagement. Reported as most motivating were the expectations of instant affective rewards reaped during and after PA, including pleasure and enjoyment in the PA behaviour itself, increased mood and affect, and decreased negative affect during and after. There is growing evidence indicating that automatic processes, such as the experience of positive emotions in connection with a behaviour and in particular short-term hedonic gains, such as intense well-being during and after exercise are highly conducive to repeated and continued practice and may be amongst the strongest predictors of stable maintenance (Kahneman, 2003; Klusmann, Musculus, Sproesser, & Renner, 2016; Papies, 2017).

Emergent identities also became important in promoting continued PA. Identification as a physically active person was reported as developing across the intention to maintenance trajectory, as well as the connection with other physically active adults and the feeling of

belonging to physical activity groups which this new identity facilitated. There is broad theoretical support for the proposition that changes in identity influenced by behaviour adoption strengthen the likelihood of continued maintenance (Giacobbi Jr, 2016). Theory posits that identity gives us a coherent and persistent sense of who we are (Markus, 1987) and generates a set of rules that govern identity-congruent behaviour. This is particularly the case where the identity is tied to a specific behaviour; for example, people who identify as ‘runners’ must engage in the behaviour of ‘running’ to maintain such an identity (West & Brown, 2013). In this way appreciation of a physically active identity contributes to more sustainable behaviour change (Kwasnicka et al., 2016; West & Brown, 2013).

Enduring change is more likely if the underlying processes can become less effortful, more pleasurable and in some way connected to our sense of self (Caldwell et al., 2018). Across time and with practice, a complicated behaviour such as PA can shift from being triggered primarily by reflective processes to primarily by automatic processes, such as habit, expectations of positive affect, and shift in identity. PA interventions for adults with T2D could profitably exploit these findings relating to habit, pleasure and identity. Interventions featuring behaviour change techniques related to routinization and habit formation, can potentially help take the effort out of self-regulation and increase the likelihood of developing sustained PA maintenance. The pleasure factor, including the experience of heightened positive affect during and after exercise is increasingly recognized as a significant predictor of physical activity behaviour for the general adult population (Schöndube et al., 2016). It is important for those delivering interventions to communicate these persuasive benefits that have been shown to emerge, and to stress that they may take time to materialize. Maintaining PA requires an ongoing effort and an intervention duration of more than one year to scaffold patients on their journey to stable maintenance would be optimal (Cradock et al., 2017; Genevieve F Dunton, 2018; Penn et al., 2013). Where this is not possible, follow-ups to

initial interventions, or referral to social support networks and groups that can support patients on the road to maintenance.

When considering the findings and implications of this study, limitations must be acknowledged. Strategies cited by participants as instrumental to their success may not be as important as they believed, and may also be commonly used by people with T2D who have not been successful in maintaining PA. People do not always have insight into the true causes of their behaviour (Nisbett & Wilson, 1977). Likewise, participants' T2D duration varied widely, and it is possible that those who had been diagnosed many years earlier did not recall the experiences related to PA intention formation and initial adoption as clearly as those who had more recently become regular maintainers of recommended PA. Recruiting participants from online T2D and/ or PA support groups increases the likelihood that they may have learned much about PA maintenance from their social networks. The study sample was furthermore taken from four different countries: seven participants from the UK, four from the USA, four from Australia and three from Canada. However, we tried to maintain an international focus and reduce attention to factors related to specific geographical socioenvironmental factors (e.g. the Australian healthcare system, specific national guidelines for T2D care), which may have been more or less influential in the uptake and maintenance of PA.

In summary, this study documented factors influencing intention formation, adoption and maintenance of physical activity in adults with T2D who were successful in transitioning from a reportedly inactive previous lifestyle to incorporating regular physical activity at levels recommended for diabetes management. A course towards maintenance was mapped which showed that reflective processes were perceived as more important when attempting to adopt the PA behaviour, and that automatic processes, such as experiences associated with pleasure, identity and habit, that transpire at an implicit level beyond conscious awareness,

were perceived as the prominent factors driving maintenance (Castonguay & Miquelon, 2017; North, 2012). These findings testify to the complexity of the journey to sustained PA maintenance, and suggest that interventions to support individuals on this journey should feature components tailored to specific points on the intention to maintenance trajectory.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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