

# BMJ Open 'It's a Dance Between Managing Both': a qualitative study exploring perspectives of persons with knee osteoarthritis and type 2 diabetes mellitus on the impact of osteoarthritis on diabetes management and daily life

Lauren K King <sup>1,2</sup>, Esther Waugh,<sup>3</sup> Crystal MacKay <sup>3</sup>, Ian Stanaitis,<sup>2</sup> Jane Stretton,<sup>2</sup> Alanna Weisman,<sup>1,4</sup> Noah M Ivers,<sup>2,5</sup> Lorraine L Lipscombe,<sup>1,2</sup> Gillian Hawker <sup>1,2</sup>, Janet A Parsons<sup>3,6</sup>

**To cite:** King LK, Waugh E, MacKay C, *et al.* 'It's a Dance Between Managing Both': a qualitative study exploring perspectives of persons with knee osteoarthritis and type 2 diabetes mellitus on the impact of osteoarthritis on diabetes management and daily life. *BMJ Open* 2022;**12**:e061472. doi:10.1136/bmjopen-2022-061472

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-061472>).

Received 26 January 2022  
Accepted 17 October 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

## Correspondence to

Dr Lauren K King;  
[l.king@mail.utoronto.ca](mailto:l.king@mail.utoronto.ca)

## ABSTRACT

**Objectives** Type 2 diabetes (T2DM) and knee osteoarthritis (OA) commonly co-occur and epidemiologic studies suggest concomitant symptomatic knee OA increases the risk of T2DM complications. We sought to explore the experiences and perspectives of individuals' living with both symptomatic knee OA and T2DM, with a focus on the impact of OA on T2DM management and daily life.

**Design** We conducted qualitative semistructured telephone interviews with persons living with T2DM and knee OA. We inductively coded and analysed interview transcripts, informed by interpretative description.

**Setting** We recruited participants from a community arthritis self-management programme and an academic hospital's family medicine clinic in Ontario, Canada.

**Participants** We included 18 participants who had a physician diagnosis of both T2DM and knee OA, with variation age, gender, and duration of T2DM and knee OA.

**Results** Participants with T2DM described how concomitant painful and disabling knee OA made it difficult to engage in physical activity, negatively impacting blood glucose control. Joint pain itself, associated sleep disturbance and emotional distress were also seen to affect blood glucose control. Beyond diabetes management, the impact of OA-related pain and functional limitations on nearly all aspects of daily life led participants to view their OA as important. Despite this, many participants described that their health professionals paid little attention to their OA, which left them to self-manage. Balancing both conditions also required navigating a medical system that provided piecemeal care.

**Conclusions** Individuals with T2DM view symptomatic knee OA as an important barrier to both T2DM management and overall well-being, yet are frequently met with insufficient support from health professionals. Greater recognition and management of knee OA in persons with T2DM could help improve patient-centred care and potentially disease outcomes.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Using a qualitative design, our study illuminates the multidimensional impact of knee osteoarthritis on type 2 diabetes management and quality of life, including effects of pain, physical inactivity and emotional distress.
- ⇒ The majority of individuals in our sample were past clients of an Arthritis Education and Rehabilitation Programme and may be over-representative of people who have successfully accessed care.
- ⇒ While we aimed to recruit individuals from different geographical settings (urban vs rural), and varying age and gender, we did not have information on ethnicity and some important perspectives may not be represented.

## INTRODUCTION

Type 2 diabetes (T2DM) is recognised as a serious public health concern with considerable impact on human life. Despite advances in clinical care, the number of individuals with T2DM worldwide continues to rise,<sup>1</sup> and solutions to reduce associated adverse health outcomes, including higher risk of death and disability,<sup>2</sup> are critically needed. Nearly one in three individuals living with T2DM also has osteoarthritis (OA),<sup>3</sup> the most common form of arthritis, characterised by chronic joint pain and functional impairments. The conditions frequently coexist owing to shared risk factors, such as older age and overweight/obesity.<sup>2,4</sup> The knee is most frequently affected by OA.<sup>4</sup> Epidemiological studies reveal knee OA to be an independent risk factor for both development of incident T2DM,<sup>5,6</sup> and for diabetes-specific complications and cardiovascular

events in those with prevalent T2DM.<sup>7</sup> Knee OA, a leading cause of impaired mobility,<sup>8</sup> may impede engagement in physical activity that is strongly recommended in international T2DM guidelines.<sup>9,10</sup> However, there is potential for broader and multidimensional effects of knee OA on the lives of persons living with T2DM. Knee OA-related depression, fatigue and poor sleep quality<sup>11,12</sup> may also limit a person's ability to fully engage in T2DM care. The literature currently lacks patients' perspectives on how T2DM and OA interact.

Given the growing emphasis on person-centred research and understanding interactions among multiple chronic conditions, this qualitative study aimed to explore how persons with T2DM perceive the impact of knee OA on their T2DM management and daily lives. A better understanding of these disease relationships is critical to identifying strategies to optimise care and disease outcomes of persons with T2DM. This study will illuminate, for the first time, the prominence of OA in their lives and the resulting complex illness experiences faced by these individuals with a common cluster of conditions.

## METHODS

### Study design

This study employed the qualitative methodology of interpretive description. Interpretive description seeks to understand clinical phenomena through identifying commonalities and thematic patterns across participant perspectives, and to characterise each phenomenon in a theoretically useful manner to inform clinical practice.<sup>13</sup> The interpretivist stance focuses on how people make sense of their lived experiences, the meanings they assign to them (such as health symptoms and behaviours), and views patients as experts on their own lives.<sup>14</sup>

We followed the Consolidated Criteria for Reporting Qualitative Studies guidelines for reporting qualitative research.

### Sampling

We recruited participants through the Arthritis Society Canada's Arthritis Rehabilitation and Education Programme in Ontario, Canada (a self-management programme consisting of an education class and/or a one-on-one visit with an arthritis therapist), and through the family medicine clinic at Women's College Hospital, an academic hospital in Toronto, Canada. Individuals aged 45 years or older and who had a physician diagnosis of both T2DM and knee OA were invited to participate. We aimed to sample a range of ages and disease duration, both of T2DM and knee OA. Recruitment was guided by conceptual saturation of themes.<sup>15</sup>

### Data collection

A semistructured interview guide was developed, framed around the research aims. The interview guide (online supplemental material) focused on the following topic areas: participants' experiences living with T2DM and

with OA, separately, and then their perspectives on the intersection between the two conditions. Interview guides were kept flexible and participants were encouraged to discuss any aspect of the topics that they felt were relevant. Finally, participants were asked their age group, gender, years since diagnosis of T2DM and treatments currently used, and years since diagnosis of knee OA. Residence (urban, suburban, rural) was determined by Rurality Index of Ontario.<sup>16</sup> Level of knee OA pain was assessed using Western Ontario and McMaster Universities Osteoarthritis Index pain subscale,<sup>17</sup> and level of walking difficulty was assessed using the Heath Assessment Questionnaire<sup>18</sup> mobility item.

Interviews were conducted by telephone, by one of two researchers (EW or LKK). Interviews lasted 30–50 min. Interviews were audio recorded and transcribed verbatim. Data were managed using NVivo V.12 software (QSR International Pty Ltd., Burlington, MA, USA).

### Analysis

Data collection and analysis occurred concurrently in an iterative process.<sup>14</sup> An inductive thematic approach was employed. The analytic team (LKK, EW, CM, IS) comprised individuals with qualitative, methodological and substantive expertise and included both interviewers. First, a coding framework was developed, based on the first six transcripts, that was sequentially refined during meetings of the analytic team. Once the coding framework was established, it was used to code the remaining transcripts.

Analysis was informed by the research aims, the clinical experiences of the research team, comprising rheumatologists and physical therapists, and the theory of self-care of chronic illness,<sup>19</sup> which was introduced during the analysis phase. Memos were written to support development of codes and derivation of themes. Constant comparative analysis allowed in-depth insights into similarities and differences across interviews.<sup>20</sup> Interpretations were cross-referenced with the analytic team, and two senior researchers (JAP and GH). Authors kept an interrogating stance towards the data, to explore alternative explanations of the findings.<sup>21</sup> We applied the eight key markers of rigour in qualitative research, as described by Tracy.<sup>22</sup> For instance, use of multiple analysts, analytic memos, audit trail and supporting data provided rich rigour, credibility was strengthened by thick description, and we used reflexive research practices.

### Patient and public involvement

This study was conducted with important input from three patient research partners, one of whom is a co-author (JS), to identify research priorities and review interpretations of results. Interested study participants were provided a summary of the research findings.

## RESULTS

We interviewed 18 participants living with both T2DM and knee OA, representing a range of both OA and T2DM

**Table 1** Characteristics of participants (n=18)

Characteristic	N (%)
Gender, woman	9 (50.0)
Age (years)	
40–49	2 (11.1)
50–59	2 (11.1)
60–69	5 (27.8)
≥70	9 (50.0)
Residence	
Urban	12 (66.7)
Suburban	4 (22.2)
Rural	2 (11.1)
Years since type 2 diabetes diagnosis	
0–9	9 (50.0)
10–19	5 (27.8)
≥20	4 (22.2)
Years since osteoarthritis diagnosis	
0–9	5 (27.8)
10–19	5 (27.8)
≥20	8 (44.4)
Self-reported ability to walk outdoors on flat ground?	
Without any difficulty	5 (27.8)
With some difficulty	10 (55.6)
With much difficulty	2 (11.1)
Unable to do	1 (5.6)
Knee osteoarthritis pain, WOMAC pain subscale (0–20), mean (SD)	8.17 (4.84) (score range: 2–20)
WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.	

disease severity. Participants recruited from Arthritis Society Canada (n=14) are denoted as ‘PAREP’ and from family medicine (n=4) as ‘PEFP’. Participant characteristics are shown in [table 1](#).

Three overarching themes were constructed from the data: (1) negative impact of OA on diabetes control; (2) prominence of OA; (3) minimisation of OA by health professionals. Findings are presented with illustrative quotes from participant interviews. Additional quotes are presented in [table 2](#).

### Theme 1: negative impact of OA on diabetes control

This theme describes the perspectives of participants on how knee OA affected their diabetes management. Participants characterised ‘successful’ diabetes management as meeting target blood glucose values.

All participants said they recognised that regular physical activity was a key part of their diabetes management, but that their knee OA often interfered with getting enough exercise. As one participant commented,

I know for diabetes, particularly, I need to exercise, but if you're having knee pain then it's so hard to achieve that, the level of exercise you want. That is, I think, the biggest problem having these two conditions. PEFP-102

Participants spoke about how there were often days when they felt they had no option but to forgo physical activity due to their symptomatic knee OA. Insufficiently treated pain was a powerful force, halting even their best intentions to be active.

And the arthritis affects my diabetes care because, you know, sometimes I can't just go out and exercise. I just can't do it, the pain. PAREP-407

Participants described the effects that cutting back their physical activity had on their blood glucose control. They were both the subject experiencing the phenomenon and the expert interpreting it.

That [knee] was really bothering me, so I was in a lot of pain, so I stopped exercising so my sugars went up. PAREP-402

Participants described the consequences that resulted from worsening blood glucose control. One participant attributed their progression from pre-diabetes to diabetes to their OA-related activity limitations and physical inactivity.

I wasn't managing it [diabetes] well and I must say that's partly attributable to the OA... I was less active and eventually I was diagnosed with full blown diabetes. PAREP-405

Other participants described how their decline in physical activity had consequences for how their T2DM was managed. For example, participants described either having to start medications, when T2DM had previously been managed with diet and physical activity, or increasing their medications, if already on this form of therapy. Participants demonstrated their insight into how knee OA led to the need to escalate their T2DM management.

I have the knee one, OA, so that kind of flared up. Now, the walks have stopped, so things are kind of falling back, very poor activity and poor ... extreme fatigue. Now they think that since I can't manage it by diet and exercise, it's time to start the medicine. PAREP-404

Beyond physical inactivity, the pain itself was perceived to affect their blood glucose control. Some participants described how the state of being consumed with intense pain could trigger worsening blood glucose levels.

I know pain can really play hell on my blood work ... It can vary my blood sugar so much ... I know the pain will cause a higher spike in my blood sugars. PAREP-414

**Table 2** Additional illustrative quotes supporting themes and subthemes

Theme	Illustrative quotes
<b>1.OA impacts diabetes control</b>	<p>'I watch what I eat, and I exercise. And the reason why it [blood sugar] had gone up before was because my arthritis was bothering me, and they weren't sure what was going on, and then they found out that I had arthritis...' PAREP-402</p> <p>'The side effect of the arthritis is that I haven't been able to exercise as much to control the diabetes'. PAREP-405</p>
<b>2.The prominence of OA</b>	<p>'But it really limits what I can do for work. So, I can't stand for a long period of time, I can't walk for a long period of time, and I can't lift'. PAREP-408</p> <p>'It's becoming worse and worse. I don't have the strength on my knees. I cannot climb up stairs, and it's especially difficult to climb down the stairs to the basement and I have to put two feet on one step, one after the other. And then I lost balance very easily, so I have to grab on the stair rail very firmly. And all these sorts of mobility issues have been because of my knee pain'. PEFP-104</p> <p>'I would love to be able to do more. I would love to be able to wake up in the morning and not have to scream, trying to get my legs to move. I would love to just be able to wake up and go. I had to retire at (early 60s)because I couldn't do my job'. PAREP-414</p>
<b>3.Minimisation of OA by health professionals</b>	
<i>a. OA assessment and management minimised by healthcare providers</i>	<p>'I guess they're completely focused on the diabetes, although she does know that ... I've had major falls, I use a cane now and I have a walker, and my balance isn't all that good. But no, she [physician] doesn't pay as much attention to that as she does with my [diabetes control] numbers...' PAREP-410</p> <p>'She [family doctor] gave me the feeling there was nothing that could be done and getting that same reaction from the orthopaedic surgeon, I thought, well, I guess she's right.' PAREP-405</p>
<i>b. Personal responsibility for OA care</i>	<p>'I've also used Glucosamine for a lot of years. A lot of people say it doesn't work, but boy, every once in a while, I would say, well, maybe it doesn't work so I'd wean myself off it, and boy, it wasn't long before I would go back on it. It obviously does something for me'. PAREP-410</p> <p>'I've learnt it on my own from reading and believe it or not YouTube videos. I asked my doctor, my rheumatologist about it. I said this is what I want to do. And he said okay, as long as you think it's good for you and you don't hurt yourself. But no one has discussed specific exercises I should be doing or how I should be doing, which I would really like'. PAREP-407</p>
<i>c. Navigating siloed chronic disease care</i>	<p>'I thought everybody had pain. I didn't know any better. And then they found out I have fibromyalgia in addition. So, trying to find something that would help with everything has become sort of a test.' PAREP-409</p> <p>'You know, sometimes I wish I wasn't playing doctor myself so much.' PERP-102</p>
OA, osteoarthritis.	

Other participants described how pain impacted various aspects of their lives, which in turn further affected their blood glucose levels. A participant commented on this cascade of events—that OA pain affected sleep, and sleep affected their blood glucose levels, stating

...my sleep has been very problematic because of the OA ... if the sleep is off it will affect my diabetes. PAREP-405

Finally, participants described the emotional toll of living with chronic painful knee OA, frequently citing symptoms of anxiety and depression. Emotional distress and mental exhaustion made it difficult to stay focused on T2DM management. A recurring example was with food choices. Participants acknowledged the importance of following dietary approaches recommended for people with T2DM but emotional distress made it challenging to find the mental stamina to sustain mindful eating, which in turn led to worse blood glucose control.

When you're not feeling well, when your body is [in] chronic pain, it's hard to balance your mood and food has a lot to do with that as well. You don't always make the best decisions... PAREP-411

Participants' accounts portrayed living with OA and T2DM as a complex experience, with one condition

impacting the other in significant ways. They described how living with chronic OA-related pain had important consequences for their blood glucose management, but also had cascading multisystem effects that impinged on many other aspects of their lives.

### Theme 2: prominence of OA

This theme describes the dominating effect that OA had on participants' lives, and as a result how they valued OA care.

Participants told us that chronic painful OA affected nearly all facets of their everyday lives. Their OA made completing fundamental daily activities, such as bathing, dressing and toileting challenging. Several participants described how knee OA had forced them to change jobs or retire early. Participants alluded to how knee OA had taken away the life they had once known, with important implications for identity—life had become full of 'can'ts'.

If I go and walk, I need to sit down now to rest. And can't walk for long distances. For changing my dress, going to washroom, taking a shower, everything is changed upside down. PAREP-406

Numerous participants spoke about how they had to adapt their lives as a result, with OA taking on a greater and greater position of control. It would be their OA that

would decide what they could or could not do in a given day.

We joined aquafit ... Sometimes, my wife would say, well, you'd better take a day off. Sometimes, the knees would just be on the edge, so I wouldn't go that day. PEFP-101

As long as I don't bother my knees, my knees don't bother me. PAREP-408

Participants described the toll OA took on their quality of life. As a result of OA's prominence in their lives, participants, who were frequently living with several health conditions, were motivated to seek care for their OA.

I've lived with it [OA] for so long and it's really dominating my life right now. PAREP-405

The hold that participants' perceived knee OA to have on their lives was very much dependent on symptom severity and coping mechanisms. Two participants who reported mild knee pain, minimal functional impairment and strong social support perceived little impediment to daily life and simply accepted the co-existence of joint pain and stiffness.

I just kind of take it [knee pain] as a fact of life. PEFP-103

I just got accustomed to the aches and pains that I've had and I just get on with life. I can't dwell on it. PAREP-402

For most, however, symptomatic knee OA was viewed as an omnipresent force limiting their ability to engage in a normal daily life, motivating them to seek care.

### Theme 3: minimisation of OA by health professionals

This theme describes how participants frequently felt attention to their OA was inadequate, leaving them to hold responsibility for care.

#### OA assessment and management minimised by health professionals

Many participants described an imbalance between, on the one hand, their OA symptom state and desire to receive care, and, on the other, the attention provided to OA by their health professionals. Participants found that their concerns were frequently dismissed or not met with the level of support they felt they needed.

I have struggled with joint pain for I would say mostly 20 years now and it was dismissed I would say ... It wasn't addressed. There hasn't been any help for it or support. PAREP-411

Participants told us about how most of their care revolved around their T2DM control, describing the metric of diabetes management being their blood glucose levels. This focus on glucose measurements would overshadow other concerns, such as their knee OA, during a clinical encounter. If a health professional addressed

their OA, participants perceived less engagement in their concerns compared with attention paid to their T2DM.

But now, in the last three months, it has only been the sugar, sugar, sugar and that I should manage it. PAREP-404

He [family doctor] focuses on my diabetes; arthritis, he just refers me to the Arthritis Association. PAREP-402

#### Personal responsibility for OA care

As a result of experiencing what they characterised as insufficient support, many participants took on the responsibility for OA care themselves. Some participants described having to specifically request and organise specialist appointments, or visits with other healthcare providers.

And I thought, okay, I will call them, advocate for myself. I could never get through to these other two pain clinics ... my family doctor was initially reluctant to refer me because she said, 'oh, you'll never get in.' I pushed her, she did it and they called me within a day. PAREP-405

Participants spoke about researching OA treatments on their own and having to make the decisions of what to take or not take. Sometimes participants would call on friends or family members for advice or to help them in their decision-making. These treatments were often over-the-counter or nutraceutical therapies, gravitating to non-evidence-based OA treatments when left with little to no guidance from health professionals.

I've tried that [magnesium and lavender balm] and then as well arnica. Again, this is research on my own. I figured out totally what works, what doesn't. PAREP-411

I started taking turmeric, whether that's helped it or if that's just psychological, I don't know, but somebody said, try turmeric, it helps. So, I've been doing that for a few months. PEFP-103

#### Navigating siloed chronic disease care

Participants generally saw that there were inter-relationships among their multiple health conditions—their individual diseases were not existing in isolation. They spoke about how their T2DM and knee OA can impact one another, and about how juggling these conditions added a layer of complexity to each one's management.

And the other piece in the puzzle here, this is how everything gets into one big ball of trouble when you've got conditions like this... PAREP-405

For their T2DM and knee OA, participants described a system of piecemeal care, being left to navigate separate sets of disease information that seemed not to acknowledge one another. Participants were left to combine information, and reconcile any differences, for example,



educational materials. Participants wanted to better understand how they could optimise management of *all* of their chronic conditions together.

Yeah, because there is good information from the Canadian Diabetes Society [Diabetes Canada] and good information from the Canadian Arthritis Society. But they treat it as this is my disease and this is my disease and never the twain shall meet, but unfortunately there is a growing number of people out there that have the same issue.

## DISCUSSION

Our qualitative study illuminates the prominent and far-reaching effects of concomitant knee OA on the overall health and well-being of persons with T2DM, including a significant impact of OA on T2DM management. Participants perceived symptomatic knee OA to affect blood glucose control in multiple ways—through challenging their ability to engage in regular physical activity and also directly through pain itself, poor sleep and emotional distress. Knee OA-related pain and functional impairments constrained multiple facets of daily life, and as a result participants saw knee OA as a health priority. Despite the importance they ascribed to their knee OA, participants also perceived that they received inadequate support from their health professionals, forcing many to take responsibility for and navigate their own care. Collectively, these results suggest a missed opportunity to intervene to optimise disease outcomes and person-centred care for individuals with T2DM and concomitant knee OA.

Nearly all participants described how the presence of knee OA made it more difficult to engage in recommended physical activity for their T2DM, in turn affecting their blood glucose control. Participants reduced physical activity as a way to self-manage their joint pain when faced with a paucity of guidance, a maladaptive approach described in other studies of persons with OA<sup>23 24</sup> that underscores serious sequelae of inadequate attention to OA. By contrast, international OA guidelines strongly recommend physical activity as an important treatment to improve OA pain and physical function.<sup>25</sup>

Previous studies have described the high prevalence of depression, poor sleep quality and fatigue in persons with knee OA.<sup>11 12</sup> Participants perceived that these OA-related symptoms directly impacted their blood glucose control. A recent literature review of qualitative studies on the lived experiences of individuals with diabetes described the ‘extra work’ of T2DM management.<sup>26</sup> The mental fatigue and emotional distress that can accompany symptomatic knee OA can further ‘drain the batteries’ of individuals with T2DM who require intense stamina to fully engage and manage their T2DM.<sup>26</sup> Sleep disturbance and fatigue have been reported to affect diabetes control through multiple different mechanisms.<sup>27</sup> Our findings aligned with the theory of self-care in chronic illness, whereby

a person’s symptoms influence their chronic illness self-care, monitoring and management.<sup>19</sup> Improved care for OA-related joint pain is hence an opportunity to enable greater T2DM disease engagement and improve disease outcomes, independent of physical activity.

The value that participants placed on OA care is consistent with prior qualitative research that found nearly all older adults with T2DM valued quality of life in their diabetes care, including prioritising mobility and independence,<sup>28</sup> and that individuals with knee OA want to know treatment options available to them.<sup>29</sup> In the current study, it appeared that participants’ perceived that their healthcare priorities were not met with equal concern by their healthcare providers, resulting in what they saw as inadequate OA care. As part of a patient-centred approach, clinicians should consider ways in which OA-related pain and disability can be assessed and treated within the context of T2DM care. As multimorbidity becomes the rule rather than the exception, this will require a shift from the currently siloed and fragmented way we approach chronic disease care.<sup>30</sup>

Our study has many strengths. In keeping with rising interest in person-centred research, our qualitative study allowed for in-depth exploration regarding participants’ perceptions of the impact of knee OA on life with T2DM. Transferability of findings is strengthened by the range of OA disease duration and severity of included participants, in addition to T2DM duration. There are also limitations to our study. All participants had a diagnosis of knee OA and the majority were past clients of an Arthritis Society Canada arthritis education and rehabilitation programme and, thus, our sample may be over-representative of people who have sought and successfully accessed OA care. While our sample included individuals from different geographical settings (urban vs rural) and varying age and gender, we did not have information on ethnicity and there may be important perspectives that are not represented. There was variability among participants regarding duration of T2DM, which may be a proxy for T2DM severity and prevalence of complications. However, we did collect detailed information regarding prescribed medications or diabetes complications, which may impact individuals’ perceptions of the importance and impact of their knee OA. Thus, we may have missed some distinct views.

## CONCLUSIONS

The study has described the perceived impact of knee OA on T2DM management and daily life in persons living with T2DM. Given the rising prevalence of multimorbidity, this study captures important patient perspectives about disease inter-relationships, and specifically, potential areas to intervene to improve both T2DM outcomes and quality of life.

### Author affiliations

<sup>1</sup>Department of Medicine, University of Toronto, Toronto, Ontario, Canada

<sup>2</sup>Women's College Research Institute, Women's College Hospital, Toronto, Ontario, Canada

<sup>3</sup>Department of Physical Therapy, University of Toronto, Toronto, Ontario, Canada

<sup>4</sup>Leadership Sinai Centre for Diabetes, Mount Sinai Hospital, Toronto, Ontario, Canada

<sup>5</sup>Department of Family and Community Medicine, University of Toronto, Toronto, Ontario, Canada

<sup>6</sup>Applied Health Research Centre, St. Michael's Hospital, Unity Health Toronto, Toronto, Ontario, Canada

**Twitter** Lauren K King @Lauren\_King\_, Alanna Weisman @AlannaWeisman and Gillian Hawker @UofTDoMChair

**Acknowledgements** We would like to thank study participants for generously giving their time to be interviewed and for sharing their experiences. We also thank Sim Wong and Glorinda Lourido for their important contributions as patient research partners in this work.

**Contributors** LKK and GH conceived the study. LKK, EW, CM, IS, JS, AW, NMI, LLL GH and JAP contributed to the study design. LKK and EW contributed to data collection. LKK, EW, CM, IS, GH and JAP were involved in data analysis. LKK drafted the article with assistance from JAP. All authors critically revised the article and approved the final version for submission. All authors had full access to all the data in the study. LKK, EW, CM, IS, GH and JAP directly accessed and verified the underlying data reported in the article. LKK is the guarantor and accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

**Funding** This study was funded by a Project Grant from the Canadian Institutes of Health Research (CIHR).

**Competing interests** GH has received research support as the Sir John and Lady Eaton Professor and Chair of Medicine, Department of Medicine, University of Toronto.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by Women's College Hospital Research Ethics Board (REB #2019-0170-E) and University of Toronto Research Ethics Board (#39525). Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. The datasets generated and/or analysed during the current study are not publicly available due to the Research Ethics Board-approved study protocol. However, the data are available from the corresponding author on reasonable request.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iDs

Lauren K King <http://orcid.org/0000-0002-4721-5696>

Crystal MacKay <http://orcid.org/0000-0003-3503-7025>

Gillian Hawker <http://orcid.org/0000-0001-6358-1197>

## REFERENCES

- Khan MAB, Hashim MJ, King JK, *et al*. Epidemiology of type 2 diabetes – global burden of disease and Forecasted trends. *J Epidemiol Glob Health* 2020;10:107–11.
- Chatterjee S, Khunti K, Davies MJ. Type 2 diabetes. *The Lancet* 2017;389:2239–51.
- Louati K, Vidal C, Berenbaum F, *et al*. Association between diabetes mellitus and osteoarthritis: systematic literature review and meta-analysis. *RMD Open* 2015;1:e000077.
- Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. *The Lancet* 2019;393:1745–59.
- Kendzerska T, King LK, Lipscombe L, *et al*. The impact of hip and knee osteoarthritis on the subsequent risk of incident diabetes: a population-based cohort study. *Diabetologia* 2018;61:2290–9.
- Rahman MM, Cibere J, Anis AH, *et al*. Risk of type 2 diabetes among osteoarthritis patients in a prospective longitudinal study. *Int J Rheumatol* 2014;2014:1–7.
- Hawker GA, Croxford R, Bierman AS, *et al*. Osteoarthritis-related difficulty walking and risk for diabetes complications. *Osteoarthritis Cartilage* 2017;25:67–75.
- King LK, Kendzerska T, Waugh EJ, *et al*. Impact of osteoarthritis on difficulty walking: a population-based study. *Arthritis Care Res* 2018;70:71–9.
- Davies MJ, D'Alessio DA, Fradkin J, *et al*. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American diabetes association (ADA) and the European association for the study of diabetes (EASD). *Diabetes Care* 2018;41:2669–701.
- Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 clinical practice guidelines for the prevention and management of diabetes in Canada. *Can J Diabetes* 2018;42:S1–325.
- Hawker GA, French MR, Waugh EJ, *et al*. The multidimensionality of sleep quality and its relationship to fatigue in older adults with painful osteoarthritis. *Osteoarthritis and Cartilage* 2010;18:1365–71.
- Hawker GA, Gignac MAM, Badley E, *et al*. A longitudinal study to explain the pain-depression link in older adults with osteoarthritis. *Arthritis Care Res* 2011;63:1382–90.
- Thompson Burdine J, Thorne S, Sandhu G. Interpretive description: a flexible qualitative methodology for medical education research. *Med Educ* 2021;55:336–43.
- Green J, Thorogood N. *Qualitative methods for health research*. London: Sage, 2014.
- Saunders B, Sim J, Kingstone T, *et al*. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant* 2018;52:1893–907.
- Kralj B. *Measuring Rurality - RIO2008\_Basic: methodology and results*. Toronto, ON: Ontario Medical Association, Department of Economics, 2009.
- Bellamy N, Campbell J, Stevens J, *et al*. Validation study of a computerized version of the Western Ontario and McMaster universities VA3.0 osteoarthritis index. *J Rheumatol* 1997;24:2413–5.
- Bruce B, Fries JF. The Stanford health assessment questionnaire: dimensions and practical applications. *Health Qual Life Outcomes* 2003;1:20.
- Riegel B, Jaarsma T, Lee CS, *et al*. Integrating symptoms into the middle-range theory of self-care of chronic illness. *ANS Adv Nurs Sci* 2019;42:206–15.
- Grove RW. An analysis of the constant comparative method. *International Journal of Qualitative Studies in Education* 1988;1:273–9.
- Kvale S. *Interviews: an introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage Publications, Inc, 1996.
- Tracy SJ. Qualitative Quality: Eight “Big-Tent” Criteria for Excellent Qualitative Research. *Qualitative Inquiry* 2010;16:837–51.
- Leov J, Barrett E, Gallagher S, *et al*. A qualitative study of pain experiences in patients requiring hip and knee arthroplasty. *J Health Psychol* 2017;22:186–96.
- Sale JEM, Gignac M, Hawker G. How “bad” does the pain have to be? A qualitative study examining adherence to pain medication in older adults with osteoarthritis. *Arthritis Rheum* 2006;55:272–8.
- Bannuru RR, Osani MC, Vaysbrot EE, *et al*. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis Cartilage* 2019;27:1578–89.
- Stuckey H, Peyrot M. Living with diabetes: literature review and secondary analysis of qualitative data. *Diabet Med* 2020;37:493–503.
- Barone MTU, Menna-Barreto L. Diabetes and sleep: a complex cause-and-effect relationship. *Diabetes Res Clin Pract* 2011;91:129–37.
- Beverly EA, Wray LA, LaCoe CL, *et al*. Listening to Older Adults' Values and Preferences for Type 2 Diabetes Care: A Qualitative Study. *Diabetes Spectrum* 2014;27:44–9.



- 29 Clark JP, Hudak PL, Hawker GA, *et al.* The moving target: a qualitative study of elderly patients' decision-making regarding total joint replacement surgery. *J Bone Joint Surg Am* 2004;86:1366–74.
- 30 Ploeg J, Matthew-Maich N, Fraser K, *et al.* Managing multiple chronic conditions in the community: a Canadian qualitative study of the experiences of older adults, family caregivers and healthcare providers. *BMC Geriatr* 2017;17:40.

## **Supplemental Material**

### **Interview Guide: Patients with Diabetes and Osteoarthritis**

*Thank you for agreeing to speak with me today. I'm going to begin the interview by asking you a few questions in order to get to know you and to learn about your experience with having diabetes and osteoarthritis. We are going to be doing a study that tests an intervention to improve treatment of joint pain in people with diabetes but before we start we really want to hear from people like yourself who are living with both of these conditions. These questions serve as a guide only. We encourage you to talk about any aspect of the topic you wish. There are no right or wrong answers to these questions. Questions will start very broadly and I'll ask some more specific questions towards the very end of the interview.*

*We will be audio recording the interview, in order to capture all the details of our conversation. This is a purely voluntary activity, so remember that you may end the interview at any time. If you need to take a break, please let me know and we can do so. Also, if you feel uncomfortable with any question, tell me and we can skip it. No personal information about you will be shared with anyone outside of the study team. No identifying information will be shared in any reports or publications. While we might use direct quotes in such reports, they will only be attributed more generally to someone who is a "patient", etc. All the information provided by you will be kept strictly confidential and we hope you will feel able to speak freely as we genuinely want to hear your perspective.*

*If a question does not make sense, let me know so I can ask it more clearly. Take as much time as you like to answer the questions.*

*Do you have any questions before we begin?*

*(and if not, start recording)...*

1. Our study is focused on people living with both diabetes and joint pain due to arthritis. I'm going to ask you about each of these conditions to learn more about how they impact your life. So first of all, tell me about your diabetes.

Probes:

- How long have you had diabetes?
- How are you currently managing your diabetes – what is your current (treatment) approach? Has this changed over time?

2. So now, tell me about your joint pain. What has that experience been like?

Probes:

- How long have you had joint pain?
  - Did a physician or other health care provider diagnose you with arthritis? If so, tell me about that experience.
    - When was that?
    - What did they tell you?
  - Have you discussed your joint pain or arthritis diagnosis with the health care providers who treat your diabetes? What did *they* tell you?
  - How active or troublesome do you feel your arthritis is right now?
3. What kinds of treatments have you tried to manage your joint pain?
- Probes:
- Have you ever been seen by a physiotherapist or occupational therapist? If so, what was that experience like?
  - Who suggested you see them (physiotherapist or occupational therapist)?
  - Was this early on in your symptoms, or had they been going on for a while?
  - Have you used any other treatments or therapies for your joint pain? Who prescribed or suggested it?
4. Our study is focused on people living with *both* diabetes and arthritis. So can you tell me what it is like to live with *both* diabetes *and* pain in your joints from arthritis?
- Probes:
- How does it affect your everyday life? Your mood, being able to complete your daily tasks, keep up with friends and family, participate in activities that you enjoy?
  - What kinds of challenges do you face living with both conditions?
  - How does the one condition affect the other, in your view?
5. We're interested in your experiences participating in physical activity (e.g. activities when you are moving around, like walking). Tell me about what kinds of physical activity you typically do. What does a typical day or week look like?
- Probes:
- What activities do you like do? Have you been able to continuing doing those?
  - Tell me about the activities you finder easier and also those you find more challenging to do?
  - What seem to be the primary things that limit your ability to exercise or be active?  
(*Probes: are these symptoms related to having joint pain, or to diabetes?*)

6. How important is physical activity to you? How important is it for managing your diabetes? Your arthritis?

Probes:

- How satisfied are you with your current level of physical activity? What would you change if you could?
- There's a lot of talk of physical activity these days. What role do you feel physical activity plays in the lives of people with diabetes? What about for people with arthritis?

7. Has a health care provider ever discussed physical activity with you? If so, tell me about that experience.

Probes:

- Who has discussed it with you?
- What did you find helpful?
- What did you find unhelpful?
- What would you like to know about physical activity?

8. What kind of supports, resources or tools do you think would help in keeping physically active OR allowing you to become more physically active?

Probes:

- If you had a new resource, what would that look like?
- What do you think health care providers could do to help you be more physically active or sustain your level of physical activity? Can you give me an example?
- What kind of information on physical activity would be helpful to you?
- How would you like to receive such information? From whom? In what formats?
- Have you used technology, such as wearable devices or apps, to help you be active in the past? What was your experience like?

9. Do you have anything else you wish to say related to your health, diabetes, joint pain or physical activity? Is there anything else you'd like to raise that we didn't talk about today?

10. I would like to finish by asking about some demographic information and some details about your diabetes and arthritis:

What is your...

Age	40-49, 50-59, 60-69, 70+
Gender	Male, Female, Other, Prefer not to answer

Location of residence	Urban, suburban, rural																																				
Diabetes duration	0-4 years, 5-9 years, 10-14 years, 15-20 years, 20-24 years, 25+ years																																				
Diabetes treatment	No medications    Oral medications    Insulin (+/- oral meds)																																				
Osteoarthritis duration	0-4 years, 5-9 years, 10-14 years, 15-20 years, 20-24 years, 25+ years																																				
HAQ mobility	<p>Are you able to walk outdoors on flat ground?</p> <p><b>Without ANY difficulty    With SOME difficulty    With MUCH difficulty    UNABLE to do</b></p> <p>If difficulty or unable to: is this due to your arthritis? Yes/no</p>																																				
WOMAC pain	<p>Think about the pain you felt in your hip/knee during the last 48 hours.</p> <p>Question: How much pain do you have?</p> <table border="1"> <thead> <tr> <th></th> <th>None</th> <th>Mild</th> <th>Moderate</th> <th>Severe</th> <th>Extreme</th> </tr> </thead> <tbody> <tr> <td>1. Walking on a flat surface</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>2. Going up and down stairs</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>3. At night while in bed, pain disturbs your sleep</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>4. Sitting or lying</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>5. Standing upright</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> </tbody> </table>		None	Mild	Moderate	Severe	Extreme	1. Walking on a flat surface	<input type="checkbox"/>	2. Going up and down stairs	<input type="checkbox"/>	3. At night while in bed, pain disturbs your sleep	<input type="checkbox"/>	4. Sitting or lying	<input type="checkbox"/>	5. Standing upright	<input type="checkbox"/>																				
	None	Mild	Moderate	Severe	Extreme																																
1. Walking on a flat surface	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																
2. Going up and down stairs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																
3. At night while in bed, pain disturbs your sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																
4. Sitting or lying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																
5. Standing upright	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																

Thank you very much for your time and the information you shared today.