



# “I can do almost anything”: The experience of adults with type 2 diabetes with a yoga intervention

Herpreet Thind<sup>a,\*</sup>, Kate M. Guthrie<sup>b</sup>, Santina Horowitz<sup>c</sup>, Matthew Conrad<sup>d</sup>, Beth C. Bock<sup>b</sup>

<sup>a</sup> Department of Public Health, University of Massachusetts Lowell, 61 Wilder Street, Lowell, MA, 01854, USA

<sup>b</sup> Psychiatry & Human Behavior, The Warren Alpert Medical School of Brown University, Centers for Behavioral and Preventive Medicine, The Miriam Hospital, 167 Point Street, Providence, RI, 02903, USA

<sup>c</sup> Centers for Behavioral and Preventive Medicine, The Miriam Hospital, 167 Point Street, Providence, RI, 02903, USA

<sup>d</sup> Roger Williams University, Bristol, RI, 02809, USA

## 1. Introduction

Diabetes mellitus is a complex metabolic disease affecting about 1 in 10 American adults, and between 90 and 95 of these have type 2 diabetes (T2DM) [1]. The chronic hyperglycemia characteristic of diabetes is associated with several complications, including serious damage to kidneys, eyes, and nerves, and an increased risk of heart disease and stroke [2]. Controlling blood glucose level is critical to the management of T2DM, and typically cannot be achieved by medications alone. The current standard of care for T2DM includes nutrition counseling and recommendations to engage in regular physical activity [3]. Yoga, a mindfulness-based physical activity, may have special relevance for T2DM management. Several mechanistic pathways have been proposed by which yoga may influence outcomes among individuals with T2DM [4]. Yoga practice may reduce activation of the sympathoadrenal system and hypothalamic-pituitary-adrenal axis, enhance parasympathetic activity, and reduce stress, and may encourage self-care activities [4–6]. Several studies have examined the effect of yoga on glycemic outcomes among adults with T2DM [7–9]. Though promising, results of these studies are limited due in part to methodological concerns in study designs. Moreover, nearly all of these studies have been conducted in countries outside the United States, thereby, precluding any firm conclusions about the feasibility, acceptability and efficacy of yoga as a complementary therapy for T2DM for the US population.

*Healthy Active and In Control (HAIC)* is a pilot study examining the feasibility and preliminary efficacy of yoga for adults with T2DM. In addition to quantitative assessments of glucose management and psychological factors associated with diabetes self-care, we used a qualitative approach to understand the participants' perceptions of practicing yoga and its effects. Qualitative research has the advantage of identifying benefits and barriers of the intervention as experienced by the participants, which can be missed in quantitative assessments. Specifically, participants' qualitative response can help to explain why a program had the effect that it did or failed to demonstrate the expected

effect, while providing a more in-depth, experiential perspective on the intervention [10]. In this report, we present participants' experiences with the yoga practice and their perceptions about the intervention and its relationship to any changes in diabetes management.

## 2. Methods

Participants from this study were enrolled in the *Healthy Active and In Control (HAIC)* trial. In that randomized controlled trial, adults with T2DM were randomly assigned to either; (1) a 60-min, 12-week Iyengar yoga intervention given twice weekly, or (2) a twice-weekly 12-week program of 60 min of standard exercise (e.g., walking, stationary cycling). Both interventions were delivered in group format in two consecutive cohorts. Quantitative assessments were conducted at program entry (baseline), end of treatment (12-week), and at 3- and 6-months post-intervention. Focus groups were conducted with participants in the yoga arm at the end of the 12-week intervention. Procedures for the overall HAIC trial have been presented in detail elsewhere [11]. This paper reports on the qualitative focus group data collected from the yoga participants. IRB approval for the study was granted by The Miriam Hospital Institutional Review Board.

### 2.1. Participant recruitment

Participants for the HAIC study were recruited through the collaborating diabetes center and through advertising in the community (i.e. radio, flyers, Craigslist, etc.). Interested individuals calling the study phone line were screened by trained research assistants for eligibility. Inclusion criteria consisted of age > 18 years with T2DM for more than 6 months, and HbA1c levels > 6.5. Individuals with serious co-morbid conditions, serious psychiatric disorders, BMI ≥ 42 kg/m<sup>2</sup>, pregnancy or planned pregnancy were excluded. Individuals were also excluded who had engaged in any mindfulness-based program (e.g., yoga, Tai Chi) or stress management therapy in the past month or attended more

\* Corresponding author.

E-mail address: [herpreet\\_thind@uml.edu](mailto:herpreet_thind@uml.edu) (H. Thind).

than three such classes in the past six months. Individuals unable to read or write in English were also excluded. We used a revised Physical Activity Readiness Questionnaire (PAR-Q +) [12] to screen for diabetes-specific complications (e.g., gangrene, foot ulcer, etc.). If one or more items were endorsed on the PAR-Q+, physician consent was required for participation in the study. Eligible individuals were invited to attend an orientation session where the study was described in detail and written informed consent was obtained.

## 2.2. Yoga intervention

Participants randomized to the yoga group ( $n = 24$ ) attended 60-min, beginner-level Iyengar yoga classes conducted Tuesday and Thursday evenings at 5:30 p.m., weekly for 12 weeks. Classes were led by two certified Iyengar yoga instructors, with over 15 years of experience teaching yoga to individuals with wide range of fitness levels and medical history. Each class consisted of guided meditation and breath-work, active and passive asanas (i.e., postures/positions) including standing, sitting, twists, backbends, inversions and restorative postures and guided relaxation including Savasana (i.e. corpse-pose). These yoga sessions were designed to emphasize mindfulness (i.e., staying focused on the present moment) and a meditative state (i.e., calming and stilling the mind). Participants were encouraged to practice yoga at home at least twice/week in addition to their supervised sessions. Printed workbooks with photos of the yoga asanas and sequences were provided to participants along with props (e.g. blocks, straps) and a DVD to aid home practice.

## 2.3. Qualitative methods

Focus groups were conducted to understand participants' perceptions and beliefs about the intervention and its relationship to any changes that participants may have experienced in diabetes management. To explore the potential mechanism of yoga, we wanted to explore its effect on stress and self-care behavior. We also elicited feedback on the feasibility and acceptability of yoga and the study procedures to help identify any areas needing refinement prior to launching a future larger efficacy trial. A qualitative data collection guide was used to ensure that important topics were covered in the discussion (Table 1). These key topics included the effects of yoga on physical functioning, perceived stress and diabetes management, and logistics of the program likely to affect feasibility. A trained investigator with over 20 years of experience in qualitative research, whom the participants had not previously met, facilitated the discussion and two other members from the research team took notes. Each group lasted about 90 min, was audio recorded and transcribed verbatim. Participants received \$50 for their time.

Transcripts were reviewed by study research assistants for accuracy and completeness and then de-identified. A coding structure was developed based on the focus group agenda, and then iteratively as more nuanced concepts or emergent constructs were identified from the transcripts. Each transcript was independently coded by two researchers who have experience in behavioral interventions and training in qualitative methods. Codes were discussed, and if any discrepancies were found, they were resolved with input from the third investigator, who has over 20 years of experience using qualitative research to develop interventions and assessments. Final codes were entered into NVivo qualitative data management software for thematic analysis. Individual codes were reviewed by study investigators and summarized to identify important themes and key concepts within each theme. These data were further interpreted as relevant to the study's primary qualitative research questions and illustrative quotes were extracted.

## 3. Results

Of the 24 individuals randomized to the yoga condition, 22 were

**Table 1**  
Focus group agenda.

Yoga class experience	
1.	In one word or phrase describe your experience with the yoga program.
2.	Please describe your experience with yoga: Probe for postures, breathing exercise, meditation
3.	Please describe your experience with the postures: Probe for: specific postures, experience of maintaining the posture and breathing into it, comfort with specific pose(s), with which they felt most/least comfortable, how comfortable or complex each was over time course, which postures are still being practiced; capture rationale for each, after how many classes did they feel comfortable with postures
4.	How did you feel after a yoga class? Probe for: effects on body, when did they realize the effects, how long do the effects last, poses associated with those effects, difference in the body since starting the program.
5.	What motivated you to practice yoga? describe.
6.	What prevented you or discouraged you from yoga practice? Describe
Effect of yoga on stress and diabetes management	
1.	Tell me how your health is different since being in the program, if at all. Probe for: attributions of the effect being related to yoga experience.
2.	What physical changes, if any, have you experienced?
3.	What emotional changes, if any, have you experienced as a result of the yoga classes? Probe for: stress level/stress reduction or an increase in stress, other emotions.
4.	Are you doing anything else differently since starting yoga? Probe for: exercise, eating differently, medication adherence.
5.	Have there been any other effects of yoga?
6.	During class yoga instructor talked about awareness of the body during yoga. They may have asked you to pay attention to the 4 corners of the feet or to the 'back body' during poses. What did you think of those instructions? Probe for: awareness of body, awareness of lifestyle/behaviors.
7.	Tell me how your yoga practice has had an impact on your health. Probe for: effect on diabetes, or any co-existing condition
Yoga maintenance	
1.	Did you do any yoga at home or anywhere else other than study center during the 12 weeks of classes? If yes, where, when, how? Probe for: home practice, other studio
2.	Are you currently practicing yoga?
3.	Do you plan to continue yoga? If yes, probe for: where, when how. If not, why not?
Program evaluation and conclusion	
1.	What did you like most about the program?
2.	What did you like least about the program?
3.	Is there anything else about your experience that we should know?

able to attend a focus group discussion. Three focus groups were held between May and December 2017, one with cohort-1 participants and two with cohort-2 participants, allowing 6–9 participants in each group. Over half (59%) of the participants were women. Participant mean age was 58.5 years ( $SD = 5.33$ , range = 51 to 70); 41% were married, 77% were non-Hispanic Whites, 41% had a college or advanced degree, and 27% had annual household income of less than \$50 K. Participants were either overweight (23%) or obese (77%) (mean Body Mass Index = 34.16 kg/m<sup>2</sup>,  $SD = 4.23$ , range 25.6–40.9). Several themes and important concepts within each theme were identified (Table 2).

### 3.1. Effect of yoga

#### 3.1.1. Physical benefits

A majority of the participants reported improved flexibility after practicing yoga. Some stated that yoga might have relaxed muscles that were previously tense, and a few felt that yoga increased their muscle strength. Overall, a majority experienced improvement in their body movements not only in class, but also while performing everyday tasks, such as the ability to bend down and get up from the floor without aid, sitting cross-legged, kneeling in church, etc. "I've learned that I can be much more flexible. I can do exercises, do things that make me feel a whole lot better and feel like I can do almost anything." [Male, 55 years].

Participants also reported that yoga helped them be more mindful of their posture; they were able to attend to poor posture and correct it. One participant mentioned that she used to slouch, but, because of

**Table 2**  
Focus group themes.

Themes	Quotes [age, sex]
<b>Benefits of Yoga</b>	
<b>Physical benefits</b>	
Improved flexibility	"I do notice it's easier for me to—because I have a dog, a cat, and a 15-year-old—so when his stuff hits the floor and I notice it's so much easier to bend over and get it. Just little things like that. Yeah. I notice a difference." [52 years, Female]
Improved posture	"Before, you were limited by what you could do ... now the posture's good and everything else." [55 years, Male]
Decrease in aches and pain	"I used to always have backaches trying to sit up straight and tall, and my back is so much better, so much stronger. I mean, I used to be all tense in here, gone." [52 years, Female]
Equilibrium/balance	"I've been a diabetic for a long time, but as I aged and the diabetes progressed, that's when I would stumble, but taking the Vitamin B12 along with the yoga—the yoga really has strengthened, so it does have something to do with your core—stumbling too, but I think between those two, it has really helped not to lose my balance so much." [60 years, Female]
<b>Emotional benefits</b>	
Increase in confidence	"I think this took away a lot of the discouragement that we had. It gave us more encouragement that, 'Yeah, I'm gonna go back to the gym, too. I'm paying for it, I'm gonna meet you there'. [Chuckles] It helped a lot." [55 years, Male]
Mindfulness	"Toward the end of the yoga sessions, one of the teachers brought up the fact that there's a difference between reacting and responding and that, if you can, try to scale back on the reacting and do more responding. I noticed in my own life a few real stressful things came up after I heard that, and I reacted all right. It wasn't that I did not react, but I think I scaled it back and went into responding rather than keeping into the reacting or revving up the reacting." [63 years, Female]
Reduced stress	"Totally helped my stress level. Then leaving here, I felt like I did something good for the day. I learned from it. It was helping me. There actually are a couple of changes I've gone through that I can't explain over the past 12 weeks." [56 years, Male]
Relaxation/Calm effect	"I looked forward to each class. I did not miss any classes. I was very fortunate. I did not have any event come up that prevented my attending class. I was so glad to be able to come. And When I would leave class and drive home, I felt very calm." [63 years, Female]
<b>Effect on diet</b>	"What I found was after—because I would come straight from work to here, do the yoga, then go home. I found myself watching what I was eating because I was, okay, I just went through an hour of 'exercise'. I'm not gonna sit there and order, eat a pizza." [51 years, Male]
<b>Effect on sleep</b>	"I always have a hard time going to sleep and my hours are different and when I come to yoga and I'd go home and I would get—definitely get a good night's sleep on the yoga nights. It surprised me because I would not break a sweat with yoga and you would think that you—but because you're stretching and doing all of that, I think it just kind of like makes your body feel good and I never got cramps anymore in my legs." [60 years, Female]
<b>Effect on diabetes</b>	"It's strong, and the breathing, you're not as stressed out, 'cause you know when your stress level rises, your cortisone ... that rises, and high blood pressure, which is combined with it. It all plays a part in it. If you can get your body to relax and everything else relax—like I said, I came in here one time and I was hungry, headache, stressed out. I left here, I was not hungry. My headache was gone. I wasn't stressed out. I had a good night. That would've never happened without my yoga." [57 years, Female]
<b>Barriers to Practice and Attendance</b>	
Medical condition	"I did miss two weeks plus a day or two here. I got sick in the middle of it. I got the flu." [56 years, Male]
Traffic	"I couldn't do child's pose because I fell last year and damaged the nerve endings in right leg so I couldn't do the child pose." [60 years, Female]
Class timing	"Overall, I loved the class. What I liked least out of everything was [interstate] 95. At that time, really, it's awful." [70 years, Male]
Personal commitments (work, family)	"Mine would be the timing, I found it difficult the timing." [56 years, Female]
	"Even for me to not be at home could be stressful for me because of this. My son's on a good medication and hasn't had a seizure now in a year and a half, but when you have that sort of problem with a child, it's hard to separate. At least it has been for me. This has been huge for me to just be away for a couple—at dinnertime. It probably was the worst timing for me because they're home from school and it's dinnertime. I thought, 'Oh that's not gonna work,' but it's worked. I've done it." [56 years, Female]
<b>Perception of Yoga versus Exercise</b>	"I don't even know what the yoga class entails, but I know when I went to the gym and I got on the treadmill, that was exercise. I really, really sweated it out and was breathing heavy. It felt exhausting. I didn't do that here, I just felt relaxed in everything I did." [57 years, Female]
<b>Group Effect</b>	"What I liked most about it was getting to meet all the people that were diabetic like myself that I could talk to and I knew had some of the same issues." [59 years, Female]
<b>Study Feasibility and Acceptability</b>	
Reasons for joining study	"before I came, I was like, 'Damn. I've seen my doctor. I don't even want to go see my doctor anymore.' I was in a—not hopeless kind of way—but in a, 'Something's gonna give, because I'm kind of maxed out on meds. I don't want to start shooting up all kinds of more things that I'm doing'." [56 years, Male]
Feasibility of practicing the poses	"there were things that I could push myself to do. It was good. Some things I needed a lot of work on. Some things I may never do, but there were things that I found that I could do and I think that kept me going." [51 years, Male]
Safety	"I just to want to hit on something that she—when you were mentioning when you were doing certain poses and how it hurt after ... Well, I can feel that the next day, but in a good sense, because it kind of opened up some—it freed up some muscles that obviously I must have been tense ... - but now I was opened up and I was a little bit more relaxed. It's not that it was pain. I felt it, but that was—it was good that I felt it. As the weeks went on, I felt myself being more flexible, being able to bend down farther down and movements, and a lot of that." [57 years, Female]
Program structure	"That actually gave me comfort that somebody was keeping tabs on me and giving me reminders on a weekly basis. Because I have a tendency to forget a lot of things even though they're right in my calendar." [56 years, Male]
	"I think that they taught the class at the level that needed to be taught. She gave you a couple of things that pushed you each week—like it was a little something that pushed you a little further but it definitely was at a great pace." [60 years, Female]
<b>Home Practice and Maintenance</b>	"When I go to the gym, I go on the stretch bars, and I do stretches and moves of yoga. I don't do it at home, 'cause I go to the gym." [52 years, Female]
	"I have no space in my house, not enough space, so I can't do many. I try the backwards—the shoulder one, but my chairs are like studio-size chairs, so I can't do it." [59 years, Female]
	"I just love it and I do it at home. I go down in the basement. No one bothers me. They leave me alone and I hide. [laughter] No, I don't hide. I just absolutely—I'll do this for the rest of my life." [70 years, Male]
<b>Recommendations to Improve Yoga Program</b>	"I mean, three months is not a long time, because I just think after that you can go back into an old—your old habits. I think if it's a little bit longer, you're more prone to do this again the following year, because you've been at it." [57 years, Female]
	"If I could change anything, I would like—I mentioned it earlier, maybe a food aspect, too. Because you can do all the exercise in the world, if you're not eating right, your sugar won't" [54 years, Male]

yoga, was more aware of her posture. She stated that correcting posture not only made her feel strong, but she also felt proud, “Like a peacock, proud” [Female, 63 years]. Another participant mentioned that correct posture made him feel tall. “I know when I came into it, I was slouching ... Then at the end, I felt like I could actually stand up straight. I wonder if that affected my height. I feel like six feet [tall] right now.” [Male, 55 years].

A few participants who had musculoskeletal issues before joining the program, reported a decrease in their aches and pains. “I strengthened my knees. I stretched my knees at my level and it’s really—I mean I went through therapy for months and I have an exercise bike, but what it did for my knees was totally different than what I’ve done on machines, and so that was really beneficial.” [Female, 56 years] One participant who had backaches reported that her back felt good after yoga class and after home practice of yoga. “I have a bad back. I had a couple of vertebrae fused—put together, and when I leave here, my back feels really good, and I’m able to go home—in the morning, when I get up, I do some exercises that I learned in class. It helps make my back not so tight. I do it durin’ the day, too. It helps me be more flexible.” [Female, 63 years]. Another participant who previously experienced numbness in his leg due to the sciatic nerve problem, reported improvement since starting the program. “I find that I’m more flexible, the joints feel looser. I had a specific problem with sciatic nerve, and at least three or four times a week, I’d have the numbness in my leg. I haven’t had that in eight weeks.” [Male, 69 years].

Two participants who had problems with body equilibrium due to past medical conditions experienced improvement in their balance. “This has made my equilibrium, a little bit stronger for me, which it wasn’t. It was way off before. I couldn’t get down on the floor, and now I can get down on the floor and get back up without having to lean on something. It has helped tremendously with my equilibrium.” [Female, 58 years]. Other participants also reported improvements in the ability to do poses that required balance.

### 3.1.2. Increase in self-confidence

Many participants reported apprehension about their ability to do yoga poses, but as the classes progressed, their body flexibility improved, and they were able to do poses more effectively. They felt a sense of accomplishment after being able to do the poses they initially considered too difficult. “My favorite [part of the study] was learning that I could do what I didn’t think I could do.” [Female, 60 years] Their overall self-confidence increased, which in turn motivated them to complete the program and to engage in physical activities outside of the class, e.g. joining a gym. Participants felt they had learned something new about themselves and their own potential. “Even the confidence it gave to me though, ‘cause I didn’t have the confidence before. That’s what the yoga gave me. I said, ‘All right. Yeah, you can do it.’ ... I’d always find an excuse why I can’t bend and get that, my weight or something else like that. It showed me that I could do it.” [Male, 55 years].

### 3.1.3. Mindfulness

Participants’ description of their experience with yoga indicated that they had become more mindful. “The total change in how I feel about almost everything. It’s so totally different it’s unreal. It’s like I go home and it’s just, I can—I know how to take myself out of the stressful situations. It gave me things to be able to respond to those issues and gave me the confidence that I know now that I don’t have to react. I can just respond to everything.” [Female, 58 years].

Participants mentioned that while practicing the different poses, they were asked by the instructors to pay attention to their body parts, whether they felt weak or tense, and how their bodies responded to yoga. Each session also included the ‘body scan’ technique to increase awareness and focus on the present moment. Participants reported that doing this over time helped them to become mindful of their body and their emotional state. Breathing in and out during poses also had a soothing effect and helped them to work through discomfort to execute the poses. “It also made you aware of different parts of your body ... ‘Cause before ... you just didn’t really even think about it, but this makes you think

about how different ... your body feels when you’re sitting in the position. Well, maybe your left side feels different from your right side. They [instructors] would make you notice that. It helps out immensely, because then you can focus on that side that might be hurting more than the other. They would tell you to take your breath to that area and try and make the change. It did. It helped.” [Female, 58 years].

### 3.1.4. Emotional effects

A majority of participants reported feelings of reduced stress after practicing yoga. “The classes have been kind of a haven from the stress of the work day, somethin’ to really look forward to.” [Male, 63 years] Each class would start with the relaxation practices to free the mind of the stressors of the day and allowed participants to let go of everything and focus. Most reported feeling relaxed physically and emotionally after yoga class. For some, this effect lasted for several days after the class. This feeling of relaxation further motivated them to continue with the yoga practice. “Just the level of stress that was way up here and at the start of yoga, came all the way down. I felt better. I had had a headache. The headache was gone. I wasn’t hungry. I think it was one of the—being hungry because I had a headache, because I was stressed out. I wasn’t hungry anymore. That’s what yoga does for me or did for me then and probably what it will do if I continue down this path.” [Female, 57 years].

As alluded to above, the perceived benefits of yoga were not restricted to class practice. Participants noted that yoga gave them a tool to deal with stress in their routine lives. Participants found themselves responding to situations with acceptance where previously they would have felt stressed, for example, in traffic, or when dealing with stressful situations at work. They reported using breathing exercise to ‘stay in the moment and relax’, and learned to apply the concept of ‘responding instead of reacting’ to stressful life situations, feeling that they could handle situations calmly. “People at work that could get right on my last nerve, tend to not bother me [now]. I found a way and I believe part of it is ... because when you’re in this class and she’s teaching you, she’s like ‘ ... Bring yourself back to center. Get rid of all the outside chatter ... ’ I gotta say, this was better than going to a therapist and cheaper.” [Female, 60 years].

Yoga was perceived by most participants to be helpful for emotional well-being. One participant mentioned that she used to take medication for panic attacks, but since joining the study had used breathing techniques instead of relying on medication. Another participant indicated significant improvement in managing anger. “This has seriously helped me to calm myself down. As she said, not to react but to respond to things. I mean, it’s so totally different than it was before, ‘cause I used to ... blow up and not have control over it. It was just the way I responded to everything ... Now, I don’t blow up. I am able to calm myself down. If I feel like I’m going to get very [angry]—then I sit and I start breathing and just bring myself back into me and say, ‘Okay, it’s time to calm down. Let’s not react to this.’” [Female, 58 years].

Breathing exercises were perceived to be an important component of the yoga practice. “One of the instructors ... or maybe both—said, ‘Focus on your breathing. When you drift off, listen to your breathing. That’ll bring you back to the moment.’ That was very good. That helped me quite a bit actually. I use that all day long now.” [Male, 56 years] Attention to breath was used to control wandering minds and bring focus on the present moment. Breathing exercises were also perceived to be calming. “the breathing, it’s very centering. The instructors ... talked about your breath being the bridge between your mind and your body, and practicing your breathing during the class or outside of the class ... There’s a sense of— ... it’s kinda calmness and oneness, and there’s a nice feel to it.” [Male, 63 years].

### 3.1.5. Effect on diet

Although the study did not address diet or nutrition issues, several participants indicated improvements in their dietary habits. “I’m eating less. I’m eating half of what I was before the study ... I’m just feeling better, I can’t explain it. I’m not saying it has to do with yoga, but I think all of this

yoga started something in me.” [Male, 56 years] Participants reported paying more attention to their diet, eating less, snacking less, and eating healthier. Yoga was perceived to be a catalyst to better dietary habits in that they did not want to ‘undo’ the benefit they received from the class and, therefore, chose healthier options for food. One participant indicated that yoga would help him avoid stress-related eating and the temptation for excessive snacking. “I try to eat consciously when I eat instead of just sitting there subconsciously and just through reflex—reflexive eating. I try to sit and be conscious when I eat. I try to chew my food. That’s been helping me. I think the yoga’s been giving me a chance to—twice a week, coming down. Everything we’ve heard today, all the good things that we’ve heard, how they made us pay attention, I think has carried outside of the classroom, outside of the yoga.” [Male, 56 years] However, not everyone reported a positive effect on their diet. One participant mentioned that she started eating more, “I figured, I’m in the yoga, I could eat more.” [Female, 52 years]. Another participant stated that since it was late by the time she returned home after yoga class, she would end up eating something unhealthy.

### 3.1.6. Effect on sleep

A majority of the participants reported sleeping better after yoga practice. “After each class, I would get the best night’s sleep I’ve had in years. Would even carry over to the following day. I was coming in on Tuesdays and Thursdays, on Fridays I was still getting relaxing sleep.” [Male, 63 years] One participant mentioned that her sleep was better because she stopped getting cramps in her legs. Two participants noted that they were doing some relaxation asanas and breathing exercises to fall asleep. Four participants reported no changes in their sleep, and two stated that they had trouble sleeping on yoga nights. They acknowledged that the yoga instructor had mentioned that yoga can energize some people and relax others.

### 3.1.7. Effect on diabetes

Participants regarded the program as an opportunity to learn more about diabetes and how to manage it. One participant mentioned that she had become aware of the link between diabetes and stress as a result of the study. Some participants specifically mentioned that their HbA1c dropped and attributed it to the stress reduction experienced due to yoga practice. “It helps relax the A1C, and by stretchin’ your body out, it also helps, too. Different stretches and stuff. You breathe in and relax. Cuz a lotta the A1C comes from—I think it mostly comes from stress. It brings your sugar up. Stress also brings your sugar up.” [Male, 54 years].

## 3.2. Perception of yoga vs. exercise

Some participants perceived yoga to be an alternate form of exercise, while others did not consider it to be an exercise. Those who thought yoga was not exercise noted that, to them, exercise was more strenuous, where one is sweating and breathing heavy, and is exhausting, such as working out on a treadmill, whereas they viewed yoga as more relaxing. Further, they perceived exercise as requiring constant motion, but in yoga they would get into a pose and hold it. “... because when I think of exercise, you think of something that’s a little bit more strenuous than what we were doing.” [Female, 57 years] However, regardless of whether they saw yoga as exercise or not, all participants reported experiencing the benefits without experiencing the pain they associated with intense workouts. “My whole life, being a guy, coming up in sports and spending time doing other things, it was always—athletics was always, ‘push it to the max, push to the max ... —no pain no gain’ style. There wasn’t any of that push in this [yoga]. That’s really what actually made it enjoyable for me, was that she [instructor] was offering me personally a way to get this type of exercise and benefit of body awareness from yoga without the pain of it. Because the pain ultimately, with me, will turn me away from it.” [Male, 56 years].

## 3.3. Group effect

Support from the group members was highly appreciated by the participants. They acknowledged that everyone in class was from different walks of life, with different struggles and capabilities, but they liked the fact that they could relate to each other because everyone in the group had diabetes, something they said their family members could not relate to, or fully understand. “I’ve had diabetes for about ten years, and I was always a little ashamed of it, feeling that maybe I wasn’t doing enough to help myself. Actually, the group and everything, it actually made me a lot more cognizant that other people have it. You’re not alone. You can work through it. There’s a lot of support from everyone else. That’s helped a lot.” [Male, 55 years] They also highlighted that they felt comfortable in class because everyone belonged to a similar age group and had a body type that one would not find in a typical yoga studio. “You’re not going to a yoga studio with all these little toothpicks and they could bend and twist and do everything. You’re here with your age group, close proximity to middle age and stuff ... I’m not feeling overpowered by something else.” [Female, 60 years] Practicing yoga with individuals with similar ability was perceived to be less intimidating. They also reported a sense of accountability to the group, which motivated them to continue attending the classes. “I’m looking forward to come and visit my group, so that will push me to like, ‘You need to go. You need to go.’ If it wasn’t this group, I don’t know where I’m gonna be a little bit with what I’m going through, so it’s helped me because I know I’m coming, and I’m here to see my group.” [Female, 55 years].

## 3.4. Study feasibility and acceptability

### 3.4.1. Reasons for joining the study

Participants had a variety of reasons for joining the study. These included being referred by their physician, feeling the need for an alternative to the medications they felt ‘maxed out’ taking, having lost family members due to diabetes, wanting to lose weight, and perceiving a group intervention as an opportunity to be more social. Regardless of their reason, everyone had the same goal of improving their health condition. About half of the participants reported that at program entry they had not wanted to be randomized to the yoga condition. For example, one participant mentioned that he had taken a very intense yoga class years ago, and therefore, was hoping to be in the walking program; because he expected that he would not be able to complete an intense yoga program. Some participants were skeptical about their ability to do yoga and were also skeptical of how yoga would affect their diabetes. “I thought it [yoga] was more of an exercise routine, or somethin’ that ‘fit people’ did, not, you know, out-of-shape people like me. I didn’t think that I would be able to do it.” [Male, 51 years]. Another participant mentioned that she had wanted the walking condition because she had once taken a yoga class that involved a lot of chanting and did not like it.

### 3.4.2. Feasibility of practicing the poses

The majority of the participants appreciated that the class was designed for beginners and felt it was not too intense or tiring, allowing them to enjoy it. Many had medical issues and physical limitations due to past surgery, injury, arthritis, and similar conditions that limited their range of motion. Certain poses that required balance, such as the ‘tree pose’, were difficult for these individuals. Participants appreciated that the instructors were non-judgmental of their physical abilities and provided individual attention to each participant. The instructors would adapt poses to the limitations and needs of the participants by providing props (e.g. blocks, blankets) or asking them to use a wall for support or use chair if they had difficulty doing poses sitting on the floor. “Yeah, I did everything at the wall because of my equilibrium issue. She used to say to me, ‘Okay, try it without leaning up against the wall, but you’ve got the wall there in case you do fall.’ That was why I was concerned about yoga, ‘cause I didn’t think I’d ever be able to do it with my equilibrium

issue. They modified it for me to make it safe. That's what got me through." [Female, 58 years] About half of study participants required an adaptation of the traditional poses. The instructors would always explain not only how to do the pose properly, but why it was important to do the pose properly, which participants felt was greatly beneficial. "if they [instructors] noticed that you were doing something a little bit incorrect, they would explain to you which is the right way and the reason why. It might be something related to your body that they know, 'Oh, this pose is good for this, but don't lean your head this way. lift up.' That was a good thing." [Female, 57 years].

### 3.4.3. Safety

No serious adverse events were reported as a result of yoga practice. As expected with any physical activity, participants reported feeling sore after the first few sessions, but they reported that as the classes progressed, their muscles felt relaxed and they were able to do the poses with relative ease. There were a few minor adverse events, however. One participant reported aggravation of her fibromyalgia in week-8 after practice. Another participant mentioned that the 'downward dog' pose aggravated the arthritis in his wrist even though he used props to get in the pose. A third participant reported hurting his neck due to overextension in the *plow pose*. However, these study participants acknowledged that the yoga instructors had told them to not overexert themselves and to come out of poses if they felt pain. The instructors were "... always reminding you, 'Don't ever push to pain. Stop when you feel you can't—it's a sensation, you have to feel the sensation, not the pain.'" [Female, 53 years] All minor adverse events were resolved without medical intervention.

### 3.5. Program structure

Participants liked the overall structure of the study and professionalism of the staff. "I think what I liked best about the overall program was how much care I was given as either a potential participant or then when I was a participant." [Female, 63 years] They perceived appointment reminder calls to be helpful, in that they were being held accountable. Personal issues such as work commitments, sick family members, and classes held at around dinner time were reported as barriers by some participants. A majority of participants complained about the traffic they had to face at commuting time when driving to the yoga sessions. However, they all agreed that there was no other better time to schedule the classes.

### 3.6. Home practice and maintenance

A majority of participants reported practicing yoga at home in addition to the yoga during classes: a few were practicing at a local gym, and another reported doing chair yoga at work. Participants perceived yoga as a practice that could be conducted outside of a class setting at their own pace and practically anywhere, especially the breathing exercises. Many participants recognized that yoga practice does not have to be for a continuous hour but can be done for any duration convenient to them. They expressed an intention to continue their home practice; however, some barriers to home practice were also identified, such as limited space at home and certain times of the year when schedules were busy, e.g., during holiday season. Two participants mentioned that they prefer a structured program and guided practice to motivate them.

### 3.7. Participant recommendations to improve yoga program

When asked about recommendations to improve the program, several participants expressed that they would have liked the program to be of longer duration. They perceived that three months was not long enough to establish new habits, nor to see more concrete changes in HbA1c. They also suggested that future research should include a

nutrition component, since not all participants had received nutrition counseling from their health care providers, or the only nutrition counseling received was many years ago when they were first diagnosed with diabetes.

Overall, yoga had a very positive impact on the study participants, "My body feels really, really, really good and my mind feels just as good ... I'll never laugh at anyone who takes yoga again." [Male, 70 years].

## 4. Discussion

This qualitative research examined participants' experience with a yoga intervention for diabetes management. Yoga was perceived to be an acceptable and feasible option by individuals with T2DM. Participants reported an overall satisfaction with the practice and identified several physical and emotional benefits.

At enrollment, many study participants had low confidence in their ability to practice yoga, either due to medical limitations or being deconditioned due to their sedentary lifestyles. Also, all study participants were overweight or obese, for whom standard western exercise can be exhausting and not perceived as pleasurable [13–15]. However, the style and intensity of yoga used in this study was acceptable to the participants. A majority of participants experienced increased flexibility and improvement in body movements. Those who had musculoskeletal issues at study enrollment reported decrease in their aches and pain. Participants noticed an important, positive impact on their daily routine activities which were previously restricted. This in turn, increased their confidence to participate in other more vigorous physical activities. Thus, yoga could be a gateway activity for sedentary individuals who may shy from standard western exercise regimens.

Participants' descriptions of their experience indicated that they had become more mindful. Mindfulness is described as an awareness that arises through paying attention, characterized by intentional, non-judgmental observation of present moment experiences [16]. Participants were paying attention to their body, breath as well as emotions. A majority of participants experienced improved emotional well-being and reduced stress levels. These benefits are particularly relevant for adults with T2DM, since stress can lead to high glucose levels [17–19]. Participants highlighted the importance of breathing exercises, which they were using outside class to cope with stressful situations. The asanas, or postures, were used to improve physical fitness, but the breathing exercises were seen as an essential component of the yoga practice, without which the desired outcomes for diabetes might not have been achieved. Participants also reported an improvement in diet and sleep habits. These changes could be the result of increased awareness and decreased stress levels. It is noteworthy, that the intervention did not include any counseling on nutrition or sleep management techniques. This added benefit of yoga practice may make it even more appealing for adults with T2DM. However, improved sleep was not universally reported by participants, and it is therefore important to acknowledge that individuals may respond differently to yoga practice (i.e., being energized vs. being relaxed), and accordingly, they might benefit by practicing yoga during the morning versus evening hours.

Support from the group members was highly valued by the study participants and was one of the reasons cited for adherence with the yoga practice. Participants especially appreciated the company of other individuals dealing with the same medical condition. Past studies with diabetes patients have reported similar positive responses to group yoga sessions [20–22]. This raises the question whether yoga practice would be equally effective if practiced alone or in groups with individuals who do not have diabetes (e.g., in a yoga studio).

Participants were apprehensive at study enrollment about their ability to do yoga, as they frequently perceived it as an activity for physically fit individuals. However, they reported enjoying the lower intensity of the beginner level yoga used in this study. They also had conflicting views about whether or not yoga is a form of exercise. These attitudes and beliefs related to yoga could affect an individual's decision

to participate in the practice. The recommendations for adults with T2DM are to engage in 150 min of physical activity per week [23]. But, if yoga is not considered an exercise, or if individuals have misconceptions about the practice, those with T2DM may be less likely to join a yoga program or consider yoga as an option. Being cognizant of these attitudes can help researchers and health care providers plan strategies to improve enrollment in yoga research and practice.

Participants in this study required adaptations to the poses which made their practice more feasible, acceptable and safe. It remains an open question whether an extended yoga program of longer duration, or a program which emphasized traditional poses without adaptation would produce greater benefits than were reported in this study. Even though participants expressed immediate mental and physical benefits after the yoga class, an intervention of a longer duration might be helpful to see better long-lasting outcomes. Moreover, since diet is an important element of diabetes management, adding a nutrition component to the future intervention would be beneficial. Changes in diet reported in this study were spontaneous, instigated by the participants rather than promoted by the formal program. Further investigations are needed to understand the relationship between yoga practice and dietary changes, and investigate whether there may be a synergistic effect among adults with T2DM.

Focus groups discussions were used to determine the feasibility of study procedures and identify areas for revision for future larger efficacy trial. The overall structure of the study, including assessments and intervention components, were acceptable to study participants. Other than increasing the duration of intervention and adding a nutrition component, participants had no other major recommendations. Overall, the intervention had no major adverse events. Before each class, participants were asked to report any active injury or illness, so that the instructors could modify the poses, provide additional props or refrain individuals from practice. Even with the use of props, some poses may be difficult for individuals with certain medical condition, for example the ‘downward-dog’ pose for individuals with arthritis. More consistent emphasis on safety in future trials may help reduce the minor expected musculoskeletal injuries. Participants should be encouraged to do poses only if they can perform them comfortably and come out of the pose if it causes any discomfort.

There are certain limitations of this study that should be considered. First, the focus group discussions were conducted with 22 of 24 individuals randomized to the yoga condition. The two individuals who did not attend the focus groups also had low attendance (3 and 8 out of the 24 sessions) at the yoga classes. Their reasons for non-adherence were not elicited. It is possible that their reasons for non-adherence in the trial were different and not addressed by those who did attend the focus group. Second, the study participants were volunteers. Although about half of them wanted the standard exercise condition, they had been willing to get randomized to the yoga group. Thus, their attitude and expectation from a yoga program could be different from the general population of adults with T2DM. Finally, the guided yoga practice used in this study was based on Iyengar style and was specifically designed to cultivate mindfulness. Therefore, the effects observed in this study cannot be generalized to other styles of yoga practice.

Overall, this qualitative research strongly supports the feasibility and acceptability of the yoga intervention for adults with T2DM. Yoga practice was associated with several benefits, including stress reduction and improvement in sleep and diet, which are especially relevant for diabetes management. Future research is needed to explore the effect of different components and styles of yoga. It is also important to examine whether the effect would be similar in different settings (i.e. home, commercial yoga studio, clinic) and with diverse populations.

#### Conflicts of interest

The authors declare no conflict of interest.

#### Funding source

This study is funded by the National Center for Complementary and Integrative Health of the National Institutes of Health under award number AT008830 to Dr. Beth Bock (PI). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ctcp.2018.11.011>.

#### References

- [1] Center for Disease Control and Prevention, National Diabetes Statistics Report, Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services, Atlanta, GA, 2017 2017.
- [2] Centers for Disease Control and Prevention, National Diabetes Statistics Report: Estimates of Diabetes and its Burden in the United States, 2014, US Department of Health and Human Services, Atlanta, GA, 2014.
- [3] American Diabetes Association, 4. Lifestyle management: standards of medical care in diabetes-2018, *Diabetes Care* 41 (Suppl 1) (2018) S38–S50.
- [4] K.E. Innes, T.K. Selfe, Yoga for adults with type 2 diabetes: a systematic review of controlled trials, *J. Diabetes Res.* 2016 (2016) 6979370.
- [5] V.P. Jyotsna, S. Ambekar, R. Singla, et al., Cardiac autonomic function in patients with diabetes improves with practice of comprehensive yogic breathing program, *Indian J. Endocrinol. Metabol.* 17 (3) (2013) 480–485.
- [6] A.W. Li, C.A. Goldsmith, The effects of yoga on anxiety and stress, *Altern. Med. Rev.* 17 (1) (2012) 21–35.
- [7] H. Thind, R. Lantini, B.L. Balletto, et al., The effects of yoga among adults with type 2 diabetes: a systematic review and meta-analysis, *Prev. Med.* 105 (2017) 116–126.
- [8] J. Cui, J.H. Yan, L.M. Yan, L. Pan, J.J. Le, Y.Z. Guo, Effects of yoga in adults with type 2 diabetes mellitus: a meta-analysis, *J. Diabetes Investig.* 8 (2) (2016) 201–209.
- [9] V. Kumar, A. Jagannathan, M. Philip, A. Thulasi, P. Angadi, N. Raghuram, Role of yoga for patients with type II diabetes mellitus: a systematic review and meta-analysis, *Compl. Ther. Med.* 25 (2016) 104–112.
- [10] Q. Patton, *Qualitative Research and Evaluation Methods*, third ed., Sage Publications, Thousand Oaks, CA, 2002.
- [11] H. Thind, J.L. Fava, K.M. Guthrie, L. Stroud, G. Gopalakrishnan, M. Sillice, N. Gidron, B.C. Bock, Yoga as a complementary therapy for adults with type 2 diabetes: design and rationale of the Healthy, Active, and in Control (HA1C) study, *Diabetes Care* 28 (1) (2018) 123–132.
- [12] S. Thomas, J. Reading, R.J. Shephard, Revision of the physical activity readiness Questionnaire (PAR-Q), *Can. J. Sport Sci.* 17 (4) (1992) 338–345.
- [13] M. Hulens, G. Vansant, A.L. Claessens, R. Lysens, E. Muls, Predictors of 6-minute walk test results in lean, obese and morbidly obese women, *Scand. J. Med. Sci. Sports* 13 (2) (2003) 98–105.
- [14] P. Ekkekakis, E. Lind, S. Vazou, Exercise does not feel the same when you are overweight: the impact of self-selected and imposed intensity on affect and exertion, *Int. J. Obes.* 30 (4) (2005) 652–660 2006.
- [15] P. Ekkekakis, E. Lind, S. Vazou, Affective responses to increasing levels of exercise intensity in normal-weight, overweight, and obese middle-aged women, *Obesity (Silver Spring)* 18 (1) (2010) 79–85.
- [16] J. Kabat-Zinn, Mindfulness-based interventions in context: past, present, and future, *Clin. Psychol. Sci. Pract.* 10 (2003) 144–156.
- [17] P. Bjorntorp, G. Holm, R. Rosmond, Hypothalamic arousal, insulin resistance and Type 2 diabetes mellitus, *Diabet. Med.* 16 (5) (1999) 373–383.
- [18] T. Else, G.D. Hammer, S.J. McPhee, Chapter 21. Disorders of the adrenal cortex, in: S.J. McPhee, G.D. Hammer (Eds.), *Pathophysiology of Disease*, vol. 6, 2010.
- [19] B.R. Walker, Cortisol—cause and cure for metabolic syndrome? *Diabet. Med.* 23 (12) (2006) 1281–1288.
- [20] M. Van Puymbroeck, K. Atler, J.D. Portz, A.A. Schmid, Multidimensional improvements in health following hatha yoga for individuals with diabetic peripheral neuropathy, *Int. J. Yoga Ther.* 28 (1) (2018) 71–78.
- [21] G.K. Alexander, K.E. Innes, C.J. Brown, et al., “I could move mountains”: adults with or at risk for type 2 diabetes reflect on their experiences with yoga practice, *Diabetes Educat.* 36 (6) (2010) 965–975.
- [22] L. Skoro-Kondza, S.S. Tai, R. Gadelrab, D. Drincevic, T. Greenhalgh, Community based yoga classes for type 2 diabetes: an exploratory randomised controlled trial, *BMC Health Serv. Res.* 9 (2009) 33.
- [23] American Diabetes Association, Promoting health and reducing disparities in populations. Sec. 1. In standards of medical care in diabetes - 2017, *Diabetes Care* 40 (Suppl. 1) (2017) S6–S10.