The World Diabetes Tour: A challenge of stamina and glucose control to reach the top of Africa's highest mountain

Michael C Riddell

Citation: Riddell MC (2016) The World Diabetes Tour: A challenge of stamina and glucose control to reach the top of Africa's highest mountain. *Diabetes Care for Children & Young People* **5**: 34–9

Article points

1. This article documents the experience of the author and 11 other people with type 1 diabetes who set out to climb Mount Kilimanjaro in 2013.
2. Extremes of weather, temperature and altitude presented a host of challenges to manage their diabetes whilst also covering over 60 km in distance and 4 km in altitude.
3. Despite this, through careful glycaemic management and mutual support from the group, all 12 reached the summit.

Key words

- Diabetes management
- Endurance challenges
- Physical activity
- Sport
- Type 1 diabetes

Author

Michael Riddell is Associate Professor at York University, Toronto, ON, Canada.

In 2013, a group of 12 people with type 1 diabetes, led by the World Diabetes Tour association, trekked to the summit of Mount Kilimanjaro. The expedition was conceived to raise awareness of type 1 diabetes and to provide hope and inspiration for people living with the condition. In this article, Michael Riddell describes his experience climbing the mountain and the added challenges of type 1 diabetes and its management that the group was able to overcome. With careful glycaemic management and support from his fellow trekkers with the condition, he learned that type 1 diabetes need not be an impediment to even the most physically demanding activities.

Living with type 1 diabetes can be an exhausting challenge for some people. Why, then, would 12 people with this condition decide to climb the highest mountain in Africa, Mount Kilimanjaro? Led by Delphine Arduini of the World Diabetes Tour, in partnership with Sanofi, climbers with type 1 diabetes from around the world tackled the Type 1 Diabetes Kilimanjaro Expedition, which was developed by Ms Arduini to raise awareness of type 1 diabetes and to provide hope and inspiration for people living with the condition. We all met in the small town of Arusha, Tanzania, on 29 August 2013, the day before the trek began. As a recreational athlete myself, but not a mountain climber *per se*, I experienced a life-changing expedition that included the "highs" of meeting new people with diabetes and conquering the summit itself, and the "lows" of my own glucose control. This article highlights some of my experiences on that incredible trek.

The Type 1 Diabetes Kilimanjaro Expedition

The Kilimanjaro expedition was a six-day trek (the Machame route) that covered about 62 km, reaching a summit altitude of around 5895 metres. There were 12 trekkers with type 1 diabetes selected from around the world. After arriving in Tanzania, my Canadian colleagues (Dr Carolyn Chung and Dr Bruce Perkins, both of whom practice medicine while living with type 1 diabetes) and I organised ourselves with nine other trekkers for the expedition. This included packing enough medical supplies (insulin, blood glucose test strips and meters, needles and various high-altitude and remote-travel medications) and important personal items (clothing and footwear, toilet paper, a camera and lots of snacks). The sheer weight of the medical supplies and carbohydrate snacks to combat hypoglycaemia, carried mostly by Dr Perkins, had already begun to make our backs and shoulders ache. But we knew that no other source of life-saving medications and equipment would be at our disposal once we started trekking in the remote mountain.

High-altitude trekking in climate extremes can be difficult for anyone and can pose extra challenges for people with type 1 diabetes (Moore et al, 2001). High-altitude stress and wildly changing temperatures on this trip (ranging

from +30°C at the bottom of the mountain to –30°C at the top) can impact insulin needs and profoundly affect blood glucose meter performance. Insulin can freeze or get too warm, with both extremes rendering it useless. This type of trekking environment can also make blood glucose testing more difficult in practical terms, particularly if conditions get windy, cold, dusty or rainy – all a possibility on this trek on Africa's tallest mountain. Moreover, exercising in a high-altitude environment can cause false symptoms of hypoglycaemia as a result of cerebral hypoxia or increases in catecholamine levels, even though, conversely, the stress of it all can make glucose levels rise. High-altitude stress typically promotes a rise in blood glucose concentrations because of increases in glucose counter-regulatory hormones such as noradrenaline and cortisol (Mohajeri et al, 2015).

At the start of the trip, some of us had already started showing symptoms of severe jet lag and some traveller's sickness, which can also complicate diabetes management. Fortunately, we were all quickly learning how we could help each other out by distributing pack weight and supplies, and by eliminating some of the obvious over-packing (why I brought four pairs of shoes is still a mystery to my fellow trekkers. I was worried about my feet). For people with type 1 diabetes, having extra snacks close at hand in situations where one would not otherwise have easy access to food is critical for safety and peace of mind. It was comforting to know that we all had lots in common in this trek – diabetes, a love of exercise and nature, and a sense of purpose about the trip. But it was also very clear that we all had VERY different diabetes management strategies. We needed to be aware that, despite some initial clinical strategies put forward by Dr Perkins (an experienced trekker and clinician) and the few other experienced doctors on the trip, we would all be going through some trial and error on insulin dose adjustments and how we should be eating and snacking on the journey.

The types of insulin management strategies and the range of insulins available to those of us in the developed world are remarkable. As expected, some of us were on insulin pumps and continuous glucose monitoring (CGM) systems, while others were on multiple daily insulin injections, with or without CGM. In my opinion, no single management strategy should be considered superior for high-altitude trekking in temperature extremes – they all have some advantages and disadvantages. It is best on any journey to stick with what is working before you leave. However, it should be expected that the daily insulin needs might change once the trek begins, and frequent blood glucose monitoring is essential.

In general, high-volume, low-intensity exercise at low and moderate altitude (<4000 metres) reduces insulin needs compared to sedentary days; however, caloric consumption typically increases to cover the increased caloric expenditure. This means that total daily insulin dose might only be a little lower than it was on the days before the trek, even though higher amounts of food are typically taken. Moore et al (2001) found that total daily insulin dose dropped by as much as 50% in a large group of trekkers with type 1 diabetes climbing Mount Kilimanjaro. That group may have reduced their insulin doses too much, however, as some of the trekkers developed diabetic ketoacidosis and, overall, very few were able to reach the mountain summit.

In another study of individuals with type 1 diabetes who were trekking at lower altitudes (<5000 metres), insulin needs dropped by about 15% during the first few days of trekking but then climbed back up as blood glucose levels rose when the altitude passed 5000 metres (de Mol et al, 2001).

Page points

1. High-altitude trekking presents a number of difficulties for people with type 1 diabetes, including temperature extremes affecting insulin and the high altitude causing false symptoms of hypoglycaemia – even though blood glucose levels actually rise.
2. No single insulin management strategy is recommended; trekkers should stick to whatever regimen worked best for them before the trip started.
3. Insulin requirements may be lower at the beginning of the trip to compensate for the increased physical activity; however, caloric intake typically increases at the same time, so they are likely to decrease by only a small amount.

The author and his team, all of whom have type 1 diabetes, on the day before setting off. Photo courtesy of Hurricane Media UK Ltd.

Page points

1. Later, at higher altitudes, insulin requirements increase again, possibly to around 20% more than normal.
2. Good self-management skills, including basal and bolus dose adjustment, carbohydrate counting and hyperglycaemia troubleshooting, are essential skills for any prospective trekker with type 1 diabetes.

As measurement scores of acute mountain sickness rose, so did blood glucose levels even though food intake dropped. As such, individuals may find that initial reductions in basal insulin levels of 20–50% are needed during long trekking days, along with reductions in one's insulin-to-carbohydrate ratio. However, things change as the body begins to be exposed to high altitude, with individuals often noticing the need to increase the basal insulin dose back towards their pre-trek levels or higher, and the need to do hyperglycaemic corrections 2–4 hours after meal times.

In these conditions of changing insulin needs, the flexibility of basal–bolus insulin therapy is without question superior to fixed-proportion mixed insulin regimens, as the former allows for more practical titration of insulin needs to match food intake, management of hyperglycaemia and adjustment for the demands of physical activity. My own basal insulin rates dropped by about 30% during the first few days of the Kilimanjaro trek and then gradually increased back to normal as we gained altitude. By the last day, I found myself increasing my basal rate to 20% above normal even though it was a physically demanding climb.

Good self-management skills for insulin adjustments are essential with trekking – these include knowledge around the assessment of appropriate basal insulin doses, food bolus estimation (ideally through structured carbohydrate counting knowledge and the use of an insulin-to-carbohydrate ratio), correction bolus estimation and an approach to extra carbohydrate consumption and insulin dose adjustment for exercise. Troubleshooting for hyperglycaemia, along with knowledge of ketone testing, interpretation of results and an approach to management of ketonaemia or ketonuria, should all be deemed essential skills for the trekker with diabetes (Mohajeri et al, 2015).

Diary of the trek

Day 1

After a long bus ride to the gates of Kilimanjaro National Park (1640 metres above sea level), we were nervously excited to begin our first day of trekking (around 6 hours of walking). Already suffering from elevated blood glucose levels because of early reductions in insulin administration for a day's worth of exercise, and because of some excitement for the trek ahead, our first challenge was to consume a carbohydrate-rich meal at the steps of the gates. Testing your own blood sugars in these sorts of stressful situations in which a lot of other people with diabetes are watching can be a bit unnerving. My first pre-meal, pre-exercise blood glucose concentration was already too high even before eating. This was a frustrating experience. I was not hungry and did not eat much, and corrected the high glucose in my bloodstream with a "conservative" 50% insulin correction factor (i.e. I administered only half the amount of insulin needed to lower my blood glucose concentration back into the normal range). I did this because, while I wanted to have a little more insulin on board to correct my high blood glucose, I did not want to start exercising with high circulating insulin levels as this reduces hepatic glucose output during exercise and increases glucose removal from the bloodstream. With mostly tea in my stomach, I began the walk with the group and I was already dizzyingly weak from some sort of gastrointestinal bug.

With a peak at 5895 metres above sea level, Kilimanjaro is the highest "free-standing" mountain (i.e. one that is not part of a mountain range) in the world, although it is still much lower than Mount Everest (8848 metres), which at least two people with type 1 diabetes – Will Cross and Sebastien Sasseville – have summited. One of the entrances to Kilimanjaro, the Machame Gate, is only a little above sea level (1815 metres), and one must climb through essentially four distinct climate zones (rainforest, heather/moorland, desert and arctic), which feel like a condensed trip from the equator to the North Pole, with each zone posing different challenges for diabetes control.

Starting each day at 6 a.m. or earlier with a hot breakfast, we typically began climbing at 7 a.m. as daylight was short. Discussions about blood glucose swings the night before and bathroom needs were inevitably replaced by chats about new insulin adjustment strategies for the coming day. Overall, at the lower elevations, hypoglycaemia was much more common, as energy expenditure was high and the stress of high altitude had not yet occurred. Dehydration was also a threat in the first two days, as the temperature was high (around

28°C) and we were trekking in rainforest under a jungle canopy. Walking the first day through dripping wet rainforest, we heard lovely exotic birds and saw colobus and Sykes' monkeys. The first day's trek was around 20 km (12 miles), taking six hours to reach the first camp (Machame Camp; 3840 metres) because of frequent stops to test blood glucose levels, adjust pack weight and treat frequent hypoglycaemia. Views of the jagged Shira Ridge and the summit itself that we were trying to reach by day five were inspirational but a little daunting.

Day 2

On the second day, we rose to steaming cups of tea or coffee served in our tents by punctual and efficient porters. After breakfast, some filming and more reductions in basal insulin dose, we began up the steep trek through a savannah of tall grasses. Much of the weight we carried was our water and the snacks to treat and prevent hypoglycaemia. Most of the team noted that after breakfast their glucose levels rose dramatically during the wait for filming to take place (see our documentary at http://bit.ly/1UY5fON). This rise in blood glucose typically happens when you lower your bolus insulin dose in anticipation of increased physical activity, particularly if there is a prolonged delay before you start to exercise. Most of us then experienced a big drop in blood glucose about 1–2 hours after breakfast, while we were trekking, during peak insulin action.

During the climb, we had a beautiful view of the Western Breach and the glaciers at the summit called Uhuru Peak. We scrambled around large volcanic boulders and bizarre-looking lobelia plants and senecio trees. After descending into a small valley and crossing a brook, we ascended onto the Shira Ridge, after a total of about 5 hours of trekking. Again, our pace was slow but steady, largely because of photo taking and because of some challenges in glucose management. In a trek with 12 people with type 1 diabetes, someone is usually hypoglycaemic or hyperglycaemic. However, we did it together as a team. Just as one should manage diabetes throughout life – not in isolation.

Day 3

On the third day, we awoke at Shira camp which, at 3950 metres, was only a few metres higher in altitude than our last camp. An extra day or two of acclimatisation to trekking at a higher altitude while sleeping at a lower altitude helps to improve summit success rates (a term coined "climb high, sleep low"). By now, foot care and aches and pains were at the forefront of the mind for most of us, and we were beginning to notice that basal insulin needs were climbing back up. Most of us were also noting the greater level of perceived effort for trekking, even at the slow "pole pole" (Swahili for "slow walk") rate. Minute ventilation (i.e. breathing rate) and heart rate gradually increase during exercise as altitude rises, and atmospheric pressure drops during the trek. To maintain oxygen delivery to the exercising muscles at high altitude, the respiratory system adapts by working harder and the body increases the haematocrit in the circulation (Mohajeri et al, 2015). Steadily moving upward over long ridgelines of high desert, we noticed that trekking above 4500 metres gets much more difficult. Thankfully, I myself was feeling stronger because my stomach distress was gone. After lunch, we continued to the Lava Tower, a towering 300-foot-high volcanic rock. In the afternoon, we descended the steep track into the Great Barranco Valley to Barranco Camp (3995 metres). This completed a total day's trek of about 8 hours, once again with little total gain in altitude.

Day 4

The fourth day would be the most important with respect to acclimatisation. Starting with a mad scramble up the steep Barranco Wall, we then traversed up and down the slopes of the valleys on the route that wrapped around the mountain's southern face. Kibo's glaciers loomed above us on the left, reminding us of the elevation still to conquer. Like my diabetes, the journey seemed to have constant and seemingly limitless challenges ahead. In situations like these it was, and still is, important to celebrate the smaller accomplishments and enjoy the experiences (another 10 km walked, another blood glucose test in the normal range, an enlightening conversation with my new friend Steve Richert, a fellow trekker with diabetes who founded Living Vertical, an organisation for people with diabetes who do rock climbing and trekking (http://livingvertical.org). Breaking early for a change, we enjoyed some group time and our newly formed friendships.

"In a trek with 12 people with type 1 diabetes, someone is usually hypoglycaemic or hyperglycaemic. However, we did it together as a team. Just as one should manage diabetes throughout life – not in isolation."

"Overall, I had been increasing my basal rates from around 50% of usual at sea levels in the first few days to about 120% of usual by the end of day 6. I, and many of the others, were developing some apparent insulin resistance, which often occurs at about 4000–5000 metres in trekkers with diabetes."

Day 5

The fifth day, starting at Karanga camp (3995 metres) and ending at Barafu Camp (4630 metres), was relatively short in duration (4–5 hours) but long in effort because of the high altitude and the steady uphill climb. Barafu, designated as a basecamp for the summit to Uhuru Peak, is described as a small "flat" area on a ridge, which is exposed to the elements, cold and on a slant, making it difficult to sit, stand or sleep comfortably. With temperatures well below 0°C at dusk, insulin can freeze and glucose monitors may not work if left exposed to the cold. When glucose monitors do "work", they are prone to measurement error because of the low oxygen tension in the blood and atmosphere (Mohajeri et al, 2015). Our percent oxygen saturation was measured that night after dinner, and I recall that it ranged markedly from a high of about 90% in one trekker to a low of about 65% in another. Having low oxygen saturation (<80%) at rest at this camp is predictive of having trouble sleeping at night and lacking the stamina required to reach the summit the next day.

The author leads the ascent up the mountain. Photo courtesy of Hurricane Media UK Ltd.

Day 6: Summit day

After six days on the trail with no major catastrophic issues, we nervously prepared at the last basecamp to reach the mountain's summit. On the day before summit, we had to eat two meals close together and were instructed to get to bed early (5 p.m.), as we would start off in the middle of the night with a breakfast and a summit attempt. This change in routine resulted in considerable challenges to glucose control for me and some of the others. One of the trekkers could not eat anything because of acute mountain sickness. High altitude promotes a temporary anorexia and may cause nausea, both of which make glucose control more difficult (Brubaker, 2005). Another trekker had severe hyperglycaemia after the first meal, followed by a low during the night after bedtime insulin correction. Overall, I had been increasing my basal rates from around 50% of usual at sea levels in the first few days to about 120% of usual by the end of day 6. I, and many of the others, were developing some apparent insulin resistance, which often occurs at about 4000–5000 metres in trekkers with diabetes. I was not eating enough, either, and my energy level was dropping.

The first few hours of trekking in the dark and extreme cold (–18°C) were extremely laborious and uncomfortable. We were less able to communicate because of a lack of oxygen (every step I took caused me to gasp for air) and we eventually broke up into two separate groups. Although it is necessary to keep together in clusters for safety, it was difficult to stop and wait for people who were having difficulty since you would get cold very fast. False symptoms of hypoglycaemia because of the high altitude were common – it felt to me like something was terribly wrong with my glucose, but I was able to test and appeared to be OK from a physiological perspective. An experienced trekker with diabetes, who has published an article on the topic (Brubaker, 2005), told me to take a "high" and "low" blood glucose control solution, which you can get from a pharmacy, to test your meter accuracy. This was a very good idea as it was sometimes hard to believe

that the meter was accurate since I had symptoms that felt like a low.

The strong and beautiful sunrise occurred at about 6 a.m. on summit day after we had already been trekking for hours. Personally, I seriously questioned my ability to keep going just before that sunrise, but the stars in the sky and the headlamps glowing up the summit ahead of me kept me moving. Once the sun was up and warming me, I began to have a rush of emotions and to feel I could accomplish the last bit of the seven-hour trek to the summit from our basecamp. Reaching Stella Point (5681 metres), the rim of the mountain crater, was a major accomplishment. After some tea, photos and celebrations, it was about another hour or two, depending on your speed, to trek the last few hundred metres to the mountain peak. This is the point in the day when it is common to see other trekkers (with diabetes or otherwise) flat on their backs unable to go any further, or with porters almost dragging them up to the top.

Reaching the Uhuru Peak, the highest point in Africa, was an incredible feat for our team. We had spent a week together and our emotions were at an all-time high. We clustered together at the top in two separate groups, spaced about 45 minutes apart, for photos, hugs and celebrations. The sense that we had all accomplished something together was unforgettable. Now we just had to muster enough energy to get down. ■

Some of the team members at the end of their climb at Uhuru Peak, the highest point in Africa. Photo courtesy of Hurricane Media UK Ltd.

Brubaker PL (2005) Adventure travel and type 1 diabetes: the complicating effects of high altitude. *Diabetes Care* **28**: 2563–72

de Mol P, de Vries ST, de Koning EJ et al (2001) Increased insulin requirements during exercise at very high altitude in type 1 diabetes. *Diabetes Care* **34**: 591–5

Mohajeri S, Perkins BA, Brubaker PL et al (2015) Diabetes, trekking and high altitude: recognizing and preparing for the risks. *Diabet Med* **32**: 1425–37

Moore K, Vizzard N, Coleman C et al (2001) Extreme altitude mountaineering and type 1 diabetes; the Diabetes Federation of Ireland Kilimanjaro Expedition. *Diabet Med* **18**: 749–55

About the World Diabetes Tour

The World Diabetes Tour (WDT) association was founded in 2008 by Christophe Crampé and Delphine Arduini. It was created to help people with type 1 diabetes and raise awareness about what is possible while living with the condition. They aim to deliver a positive message of hope that diabetes doesn't need to limit anyone from realising their goals in life and living out their dreams. In 2014, in partnership with Sanofi, WDT organised the Machu Picchu Challenge for adults with type 1 diabetes.

In 2015, SWEET (Better control in Pediatric and Adolescent diabeteS: Working to crEate CEnTers of Reference) partnered with Sanofi and WDT to lead the Type 1 Diabetes Youth Challenge, exclusively dedicated to challenge teens with the condition to trek along the Samaria Gorge up to the summit of the White Mountains of Crete. These expeditions demonstrated that, with careful management of the condition, even under challenging conditions, people of all ages living with type 1 diabetes can strive for control and dare to dream.

More information and footage of WDT's events can be found at the following links.
Kilimanjaro: **www.epresspack.net/t1diabetes-kilimanjaro-expedition**
Machu Picchu: **www.epresspack.net/T1D-Challenge-Machu-Picchu**
White Mountains: **www.epresspack.net/t1dchallenge/type-1-diabetes-youth-challenge-white-mountains-crete**