



Complete Remission of Chronic Diseases & Improvement in Risk Factors: 1-Year Experimental Case Study

By: Jodh Singh Nahal | Edited by: Sara Pietropaolo | Layout by: Ahmed Nadeem

Age: 16 | Kamloops, BC

For this project, I won the Bronze Medal Excellence Award and a Western University Scholarship at the Canada-Wide Science Fair (CWSF); Genome BC Scholarship Award and the Sanofi Biogenius provincial awards; and the Best Senior Project Award, gold medal, and a Thompson Rivers University Scholarship at the Cariboo Mainline Regional Science Fair.

Globally, around 80% of older adults have at least one chronic disease (National Council on Aging, 2021). According to WHO (2019), diabetes mellitus or diabetes is a global epidemic affecting 422 million people worldwide. It is one of the leading causes of death in the world, with 4.2 million deaths in 2019 alone. According to most physicians, type-2 diabetes mellitus (T2DM) is a progressive, life-long disease, while at the same time there is a consensus that it is a metabolic disorder, and diet and lifestyle changes play a significant role in managing T2DM. It could reduce the risk of diabetes by 30-67% (Maghsoudi & Azadbakht, 2012). It has been known since 1930 that T2DM can be reversed with a whole-food plant-based (WFPB) diet (Rabinowitch, 1935), but unfortunately there is hardly any awareness about it.

This case study was started during the start of the COVID-19 pandemic, which in particular made immunocompromised people nervous. The case study participant, N.N., had T2DM and other chronic conditions; she had a family history. N.N.'s parents and grandparents have chronic diseases; her grandmother died of uncontrolled diabetes complications. Thus, N.N. was motivated to stay healthy. It was a 1-year longitudinal and experimental case study about N.N.: a 46-year-old overweight female with low energy and fatigue, and on multiple prescription medications for chronic diseases.

On the basis of extensive research, it was found that low-carb high-fat (LCHF) diets only have short-term health improvements and treat only the symptom of diabetes (high blood glucose) but not the disease, rather it makes the disease much worse because the disease is carbohydrate intolerance, and eating low-carb worsens carbohydrate intolerance. That is why WFPB diets do better in glucose tolerance tests than LCHF diets (Sweeny, 1927). Also, insulin resistance is not caused by carbohydrates, but by the storage of fat in tissues that are meant to store glucose, such as in kidneys, liver, heart, and skeletal muscle. This is lipotoxicity. When intramyocellular lipids (fat inside the muscle cells, especially the trans-fat and saturated fat) builds up, the insulin is not able to allow glucose to get into the cells, causing insulin resistance and beta-cell dysfunction (DeFronzo, 2010), and the glucose stays in the blood causing hyperglycemia. This was not known until MRI was used to see what was happening inside the muscle cells (Greger, 2016). Moreover, cardiovascular disease (CVD) accounts for 65% of all diabetes-related deaths, and LCHF diet causes CVD.

The main goal of this project was to lower HbA1c and reverse type-2 diabetes. Thereby, this study aims to investigate if it is possible to reverse chronic T2DM with diet and lifestyle modifications; and to find the effects of WFPB diet, exercise, time-restricted eating, and losing extra weight, on the blood glucose level and other health markers. To investigate this, extensive online research and meta-analysis reviews were conducted. Moreover, three comprehensive experiments, more than 200 blood glucose tests and lab tests were also conducted, along with many statistical tests.

METHODS

On the basis of extensive meta-analysis reviews, an evidence-based WFPB diet was selected for N.N. (Chen, Z. et al., 2018; Coote & Sadeghi, 2017; Maghsoudi & Azadbakht, 2012; Mayo Clinic, 2020, 2022; McMacken & Shah, 2017; Physicians Committee for Responsible Medicine, n.d.; Qian et al., 2019; Reynolds et al., 2020; Smithsonian, 2019; Tello, 2018; Toumpanakis, 2018; Tuso et al., 2013; Vieira, 2019; WebMD, 2021a; Wiginton, 2021; Yokoyama et al., 2014). Research shows that around 10% weight loss can reverse T2DM (Anderson et al., 2003; Chen Y. et al., 2018; Franz, 2007; Franz et al., 2015; Laguipo, 2019; Leontis, 2018; Maula et al., 2020; Sheehan, 2020; WebMD, 2021b), and time-restricted eating and exercise also has a major effect on the blood glucose levels (Colberg et al., 2016; University of Adelaide- ScienceDaily, 2019). Fiber reduces insulin resistance (Mayo Clinic, 2022) and is found only in plants; it also lowers the risk of heart disease (Diabète Québec, 2014; Fletcher, 2019; Grains & Legumes Nutrition Council, n.d.; Jenkins et al., 2012; McRae, 2018; Polak et al., 2015; Post et al., 2012; Roland, 2020; Schulze et al., 2007; Sievenpiper et al., 2009; Threapleton et al., 2013; Times of India, 2020). Also, binge eating on a regular basis may disturb your glucose metabolism (Fritz, 2018). All the

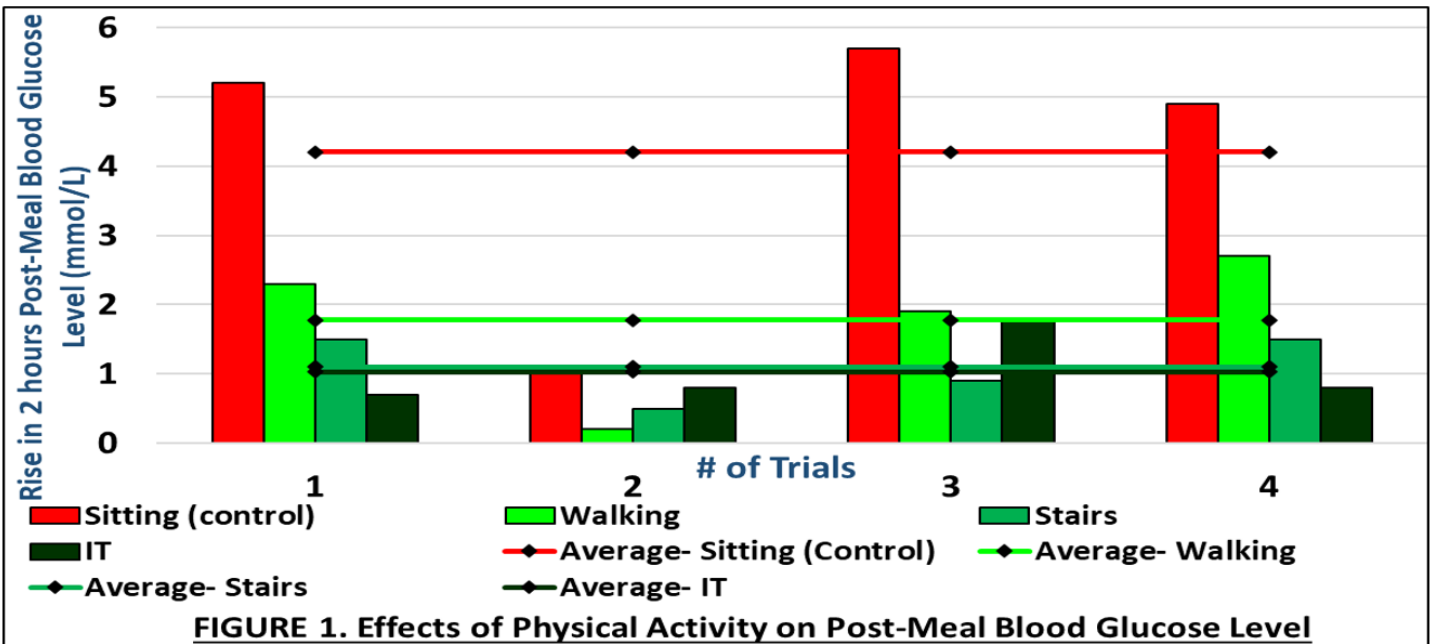


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TABLE 1. Case study participant's diet and exercise before and after intervention

N.N.'s Diet	
BEFORE INTERVENTION	AFTER INTERVENTION
<ul style="list-style-type: none"> Partially unhealthy vegetarian diet: 70% healthy (5-6 days/ week- whole grains, legumes, fruits and vegetables, some nuts) but 30% unhealthy (1-2 days/ week- fried foods, processed foods, sweets, and 3 cups dairy-yogurt/ day) 3 meals and 1-2 snacks/ day: kind of eating every now and then, no time restricted eating Around 2000 calories/ day Lots of food cravings, sometimes binge eating 	<p>The transition from unhealthy to a healthy lifestyle was in steps. The first 3 months of the intervention was 'partial' and after that it was 'full' intervention.</p> <ul style="list-style-type: none"> Partial Intervention: From the previous- before intervention diet, N.N. reduced sugar, fried and processed foods, and carbs- that were less nutritionally dense, by 50%. Full Intervention: 100% healthy vegetarian diet (WFPB diet): 7 days/ week- lots of vegetables and legumes, handful of nuts and seeds, some whole grains and fruits. No sugar, no fried and processed foods, and no wheat. The only dairy product taken was a 3/4 cup yogurt/ day. TMAD (two meals a day): time restricted eating- 1st meal at 10 am, 2nd at 5 pm. During initial 3-4 months → occasional OMAD (one meal a day). Around 1500 calories/ day: carbs 53%, fat 27%, protein 20% Rare food cravings, and no binge eating
N.N.'s Exercise	
BEFORE INTERVENTION	AFTER INTERVENTION
<ul style="list-style-type: none"> 1-2 hrs./ week low intensity exercises like walking, and sometimes hiking etc. Moderately active lifestyle but not regular exercise 	<ul style="list-style-type: none"> 5-7 hrs./ week low to moderate intensity exercises like walking, hiking, going up-down stairs, IT Moderately active lifestyle and regular exercise



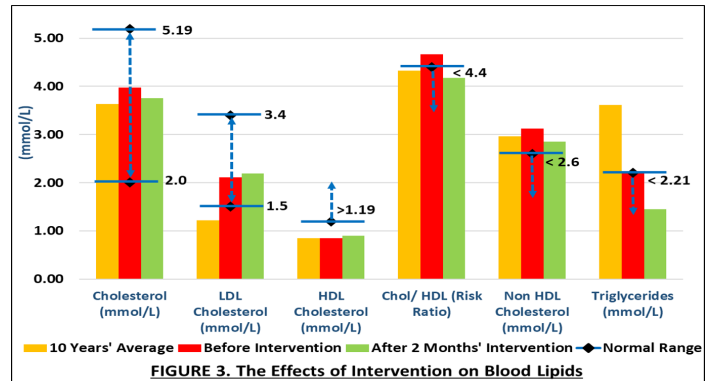


safety precautions were taken, and N.N. switched from a partially unhealthy vegetarian diet to a completely healthy vegetarian diet (WFPB diet), and also exercised regularly and did time-restricted eating, as shown in Table 1.

To lower HbA1c and reverse T2DM – the main goal of this study, three comprehensive experiments were conducted. Experiment #1 was conducted to control the post-meal blood glucose spikes; it investigated the effects of four physical activities: sitting (the control group), walking~ 5-6 km/h, moderately going up-down stairs, and interval training (IT), on 2-hours post-meal blood glucose levels, and to see if there is any statistically significant correlation between them. Experiment #2 was conducted to control morning's fasting blood glucose spikes; it tested the effects of two dinner timings: ½-hour before bed and 3-hours before bed, on next morning's fasting blood glucose levels, and to find if the result is statistically significant. Finally, Experiment #3 was conducted to test the effects of a switch from a partially unhealthy vegetarian diet to a completely healthy vegetarian diet (WFPB diet), and more regular physical activity, on lowering HbA1c and reversing type-2 diabetes. N.N.'s blood test was performed every three months at the medical laboratory for a year, followed by an appointment with her family doctor each time.

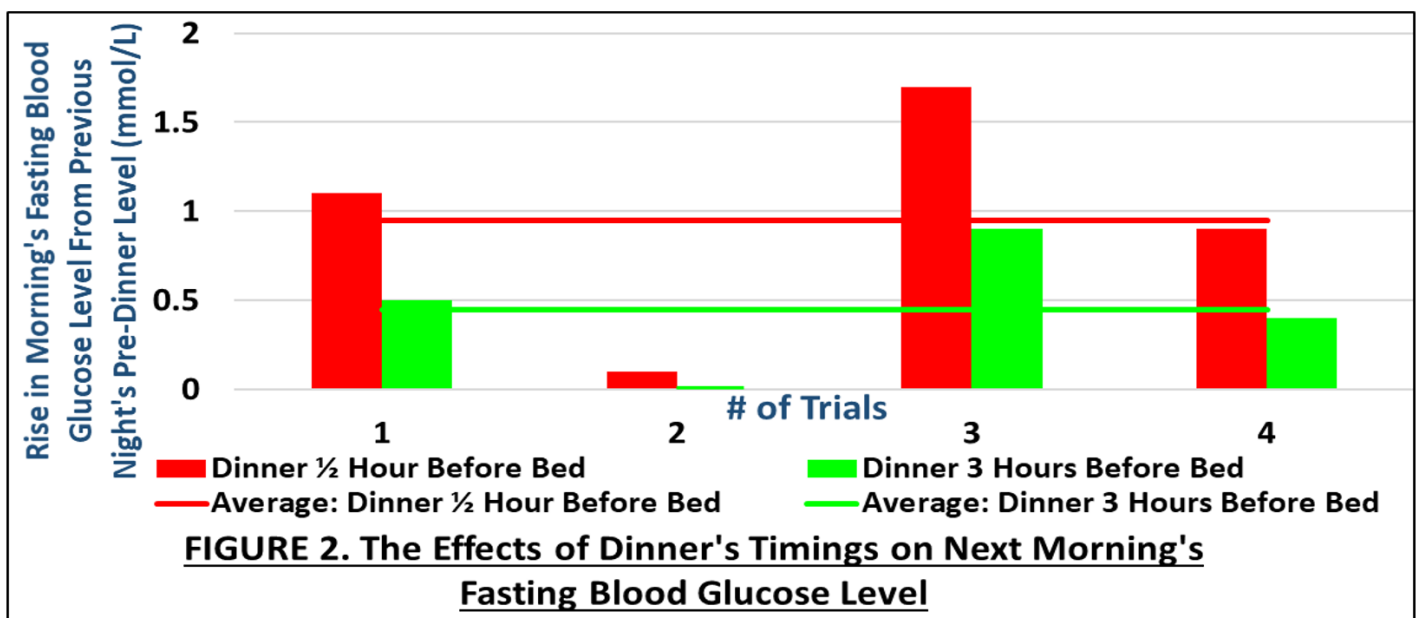
RESULTS

In Experiment #1 (Figure 1), it was found that instead of just 'sitting' (control), 30 minutes of any kind of these physical activities, 1.5 hours after meal, were 2.4 to 4.1 times more effective in controlling 2-hours post-meal blood glucose spikes. From Anova: Single Factor statistical test, it was found that there was a statistically significant difference between the four groups ($F(3,12) = 5.6 > F\text{-critical} = 3.5$, and $P\text{-value} = 0.013 < \alpha = 0.05$). Tukey HSD statistical test confirmed that the 'sitting' (control) was the only



group that was statistically significantly different from each of the other three groups – walking, stairs, and IT, with P-values <0.05 , <0.01 , and <0.01 , respectively. Through Correlation and Regression statistical tests, a strong and highly statistically-significant negative-correlation was found between the levels of physical activities and the rise in the blood glucose levels. The Pearson's correlation coefficient, $r = -0.73$, and the p-value $= 0.0013 < \alpha = 0.01$. Moreover, when an outlier, trial #2 (very less food consumption), was excluded, the correlation was even stronger, $r = -0.95$, and even more statistically significant with a very small p-value $= 2.95E-06$.

In Experiment #2 (Figure 2), it was found that if dinner is finished around 3-hours before bed instead of just before bed, it is more than twice as effective in controlling next morning's fasting blood glucose level. T-Test: Paired Two Sample for Means confirmed that both the groups were statistically significantly different from each other ($t(3) = 3.4 > t\text{-critical} = 3.2$, p-value $= 0.043 < \alpha = 0.05$).





In Experiment #3, it was found that: Weight and BMI: N.N.'s body weight dropped consistently from 150 to 125 lbs. She lost 25 lbs, which is 16.7% of the body weight. Her BMI dropped from 26.6 (overweight range) to 22.1 (normal weight range). Hypothyroidism: The Synthroid medication that N.N. used to take for the past eight years, was reduced from 125 to 100 mcg. Blood Lipids (Figure 3): N.N.'s cholesterol level dropped and got better. Her HDL cholesterol increased slightly. Although, the LDL increased slightly, but it was still in the safe normal range. The risk-ratio dropped from 4.67 to 4.17 (normal range) and the non-HDL cholesterol dropped from 3.12 to 2.85 mmol/L. Moreover, the triglycerides that was always very high (10 years' average=3.6), dropped to 1.45 mmol/L (safe normal range) – the lowest ever in 10 years. Hypertension: N.N.'s blood pressure dropped from a high 142/ 89 mmHg to a normal 126/ 78 mmHg range; and the Ramipril 10 mg medication that N.N. used to take for the past three years was stopped. HbA1c (Figure 4): There were four consecutive sharp declines in N.N.'s HbA1c after intervention (without any medicines) that never happened in the past nine years even with 2000mg Metformin/day. N.N.'s HbA1c that was very high at 8.8%, almost dropped into the pre-diabetes range. Her HbA1c dropped to 6.5% which was one of the lowest in the past 10 years; it was not only lower than before-intervention HbA1c of 8.8%, but was also lower than its nine years' average of 7.4%. She went from 2000 mg of Metformin/day to none.

DISCUSSION

Through experimental investigations, it was found that dietary and lifestyle modifications can reverse even 10 years' chronic diseases. As a result of interventions, N.N. not only lost 25-pounds and normalized her BMI, but she also reversed her 10-year chronic T2DM, 3-year chronic hypertension, and stopped all medications. Moreover, she also significantly improved her 8-year chronic hypothyroidism and her lipids profile as well. Therefore, N.N.'s chances of getting a heart attack, stroke, limb amputations, kidney, nerve, and eye damage, significantly decreased. Because of interventions, N.N. took 1,825 less prescription medicine tablets in a year, so she saved herself from various medicinal side-effects. N.N. felt more energy and strength; she was able to enjoy even mountain biking that never happened before. It was found that what medicinal treatments could not achieve in nine long years, WFPB diet and exercise achieved in just under one year without any drugs. Although, the positive changes started showing in just two months of full intervention.

CONCLUSION

It is possible to reverse even chronic diseases with dietary and lifestyle changes. WFPB diet works, besides so many health benefits, it is also good for the environment, stops animal cruelty, and eliminates most viral and bacterial infections—so it is kind of a one-diet-fix-all diseases and issues. N.N.'s family doctor was very pleased with N.N.'s blood-work report and asked her to continue what she was doing for her health. The results were

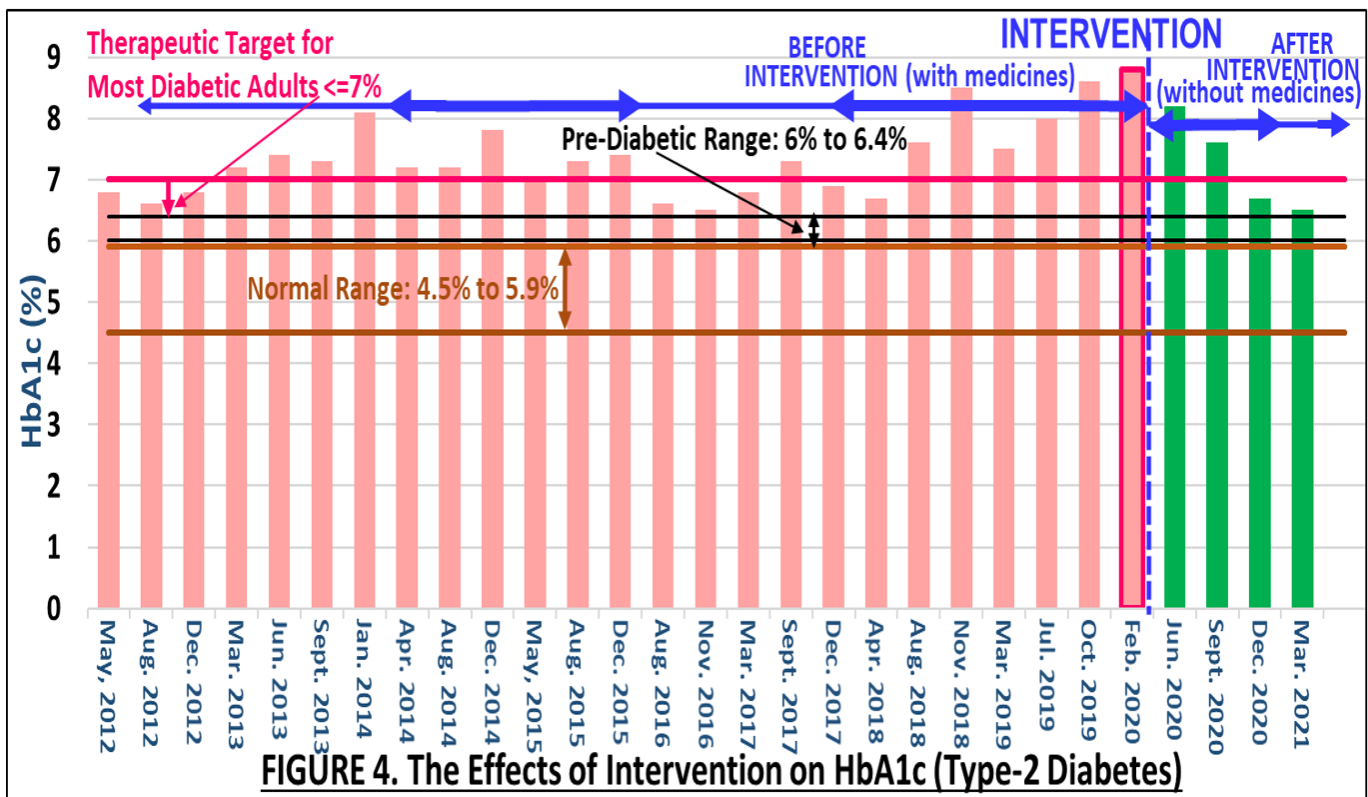


FIGURE 4. The Effects of Intervention on HbA1c (Type-2 Diabetes)



not temporary, but were rather stable and consistent. This study's outcomes unfortunately didn't come from the established medical system, but from the extensive research-and-application of the evidence-based data. It is hoped that other people get inspired by this study's results and know that it is possible to reverse not only a newly diagnosed, but even a decade long chronic diseases, and thereby, like N.N., one can significantly reduce their chances of getting a heart attack, stroke, limb amputations, kidney, nerve and eye damage etc., and live a stress-free life.

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ABOUT THE AUTHOR - JODH SINGH NAHAL

Currently, I'm pursuing biomedical engineering at UBC Vancouver after winning the Presidential Scholars Major Entrance Scholarship Award; I also won around a dozen other scholarships. I've had a strong passion for STEM and sports from my early childhood—played multiple sports throughout my school life, and have won more than 50 regional and national-level STEM awards including six awards and four scholarships at the renowned CWSF—I was selected every year from grade 7-12. This was my grade 11 project; I would like to update that the case-study participant, who later started taking wheat and sugar moderately, is still doing great after 2-years.

