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Institute *for* Healthcare Improvement

Middle East Forum on Quality & Safety in Healthcare **2023**

16-19 March, Doha

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Conflict of Interest

The authors have no conflict of interest in relation to this presentation.

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16-19 March, Doha

Association of Glycemic Control With Different Diets Followed by Patients With Type 2 Diabetes: Findings From Qatar Biobank Data

Reema Tayyem, Aya Hamdan, Karmen Alhmmadi, Yasmin Eissa, Maryam Al-Adwi, Zinab Al-Haswsa, Hiba Bawadi, and Zumin Shi

Qatar University, QU Health, College of Health Sciences, Human Nutrition

Learning Objectives

At the end of this session, participants will be able to:

1. Differentiate the impact of particular food items and nutrients on both the likelihood of developing DM and the mitigation of its consequences.
2. Recognize diets followed by patients with DM.
3. Find the associations between the diets followed by patients with DM who are living in Qatar and good glycemic control.

Introduction

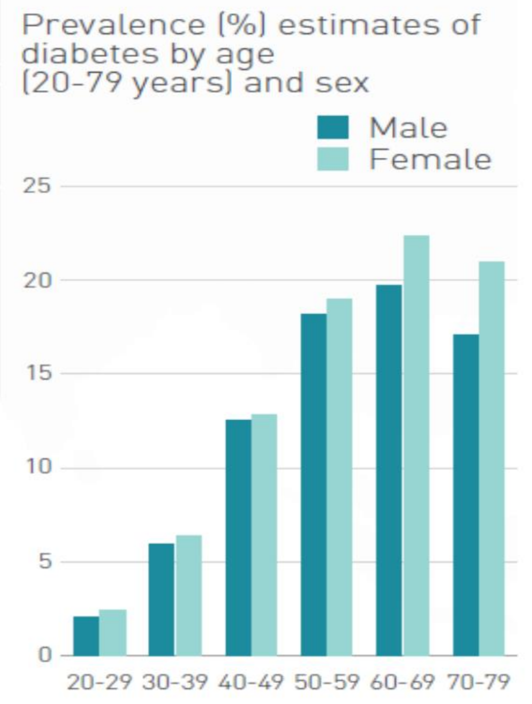
Diabetes around the world in 2021:

- 537 million adults (20-79 years) are living with diabetes - 1 in 10. This number is predicted to increase to 643 million by 2030 and 783 million by 2045.
- Over 3 in 4 adults with diabetes live in **low- and middle-income** countries.
- Diabetes is responsible for 6.7 million deaths in 2021 - 1 every 5 seconds.

IDF Diabetes Atlas 2022 Reports

What is the situation in Qatar?

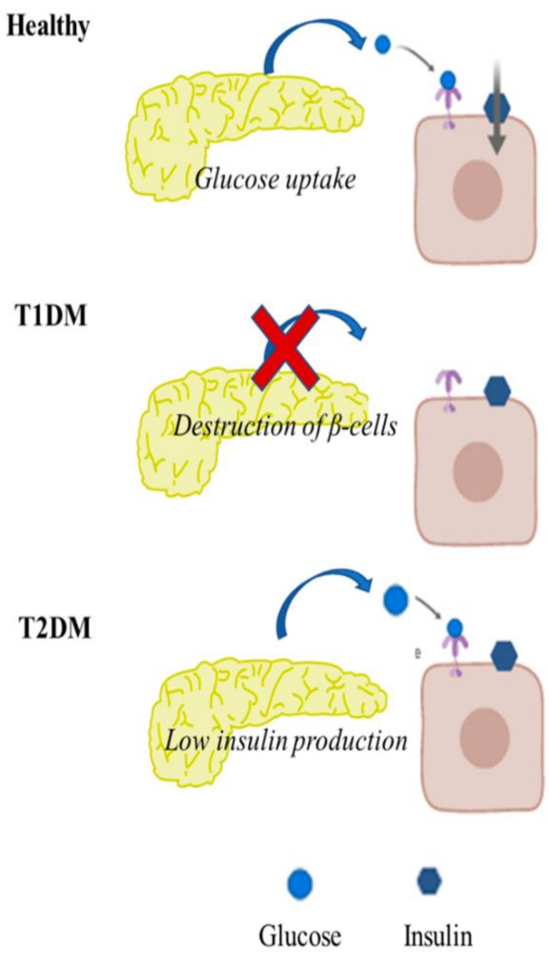
- Qatar is ranked in the top ten countries in the world for T2DM with an estimated prevalence of 17%.
- Diabetes prevalence in Qatar is twice the global prevalence.
- In a recent modeling study, the prevalence of T2DM among Qataris was projected to increase from 17% in 2012 to at least 24% by 2050.



Awad et al. Diabetes Res Clin Pract. 2018;137:100–8.

Introduction

- Diabetes mellitus (DM) is a group of metabolic diseases characterized by chronic hyperglycemia caused by one of two defects: a defect in insulin secretion or a defect in insulin action, or both.
- Diabetes is classified as type 1, type 2, gestational or other specific types.

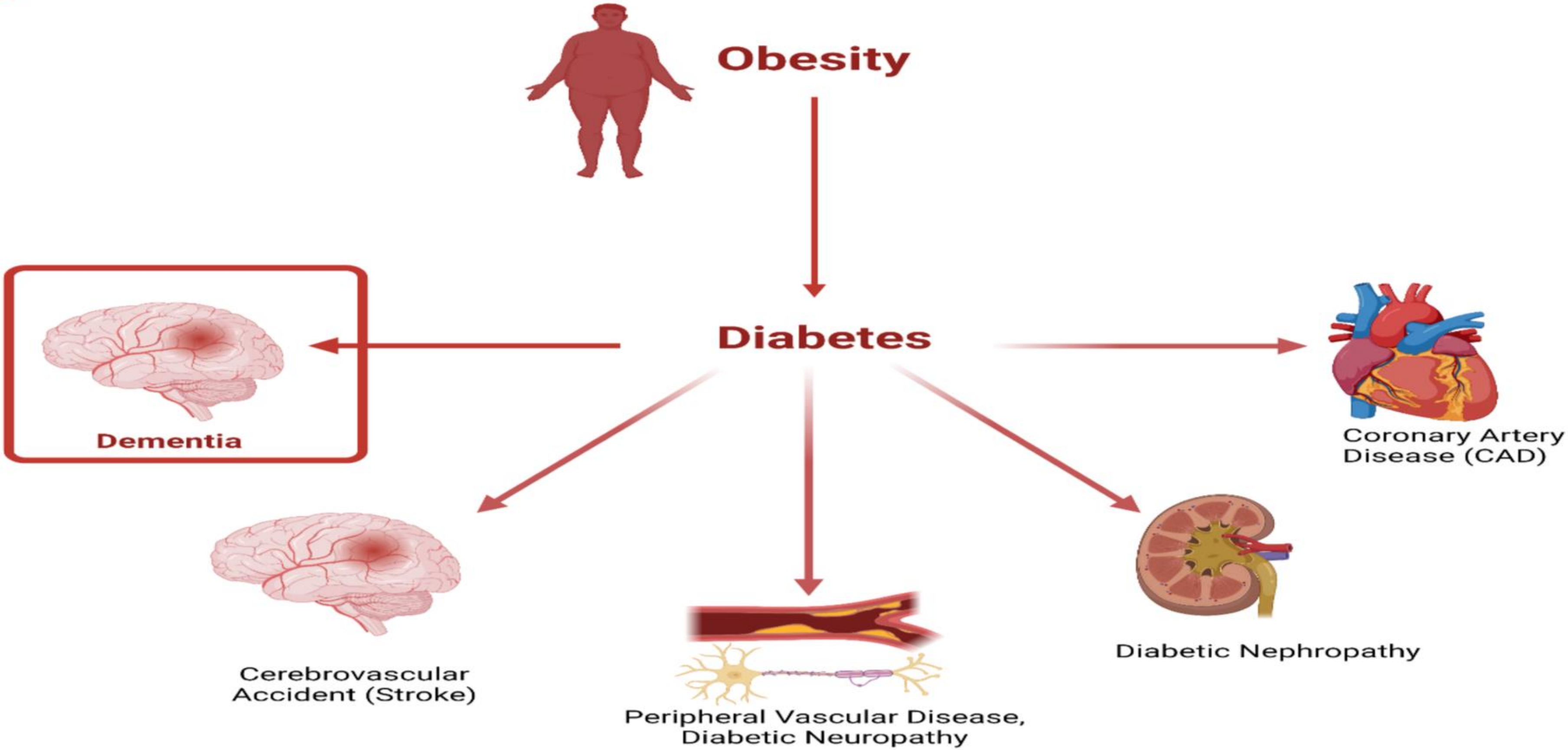


Kharroubi and Darwish. World J Diabetes. (2015) 6:850.

Risk Factors of DM

Selman, et al, The Role of Obesity and Diabetes in Dementia. ***Int. J. Mol. Sci.*** 2022, ***23***, 9267

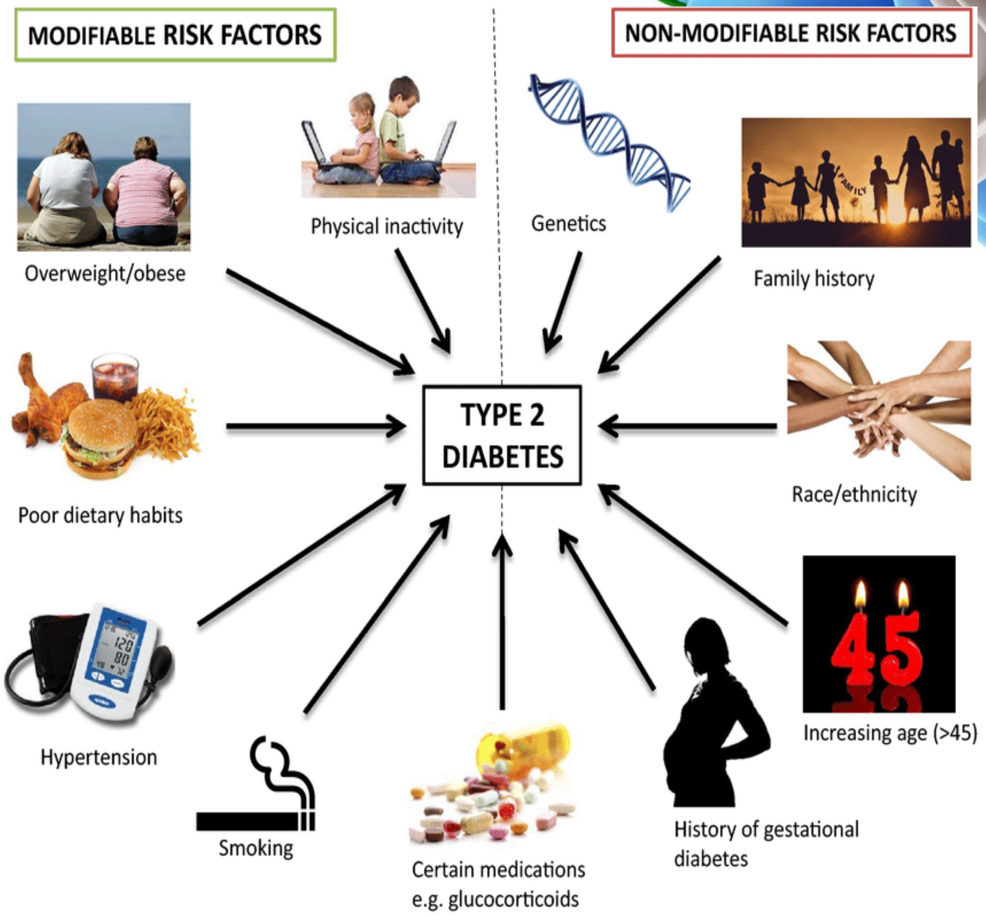
Long-term Consequences of Obesity and Diabetes Mellitus



Selman, et al, The Role of Obesity and Diabetes in Dementia. *Int. J. Mol. Sci.* 2022, *23*, 9267

The risk factors:

DM development is affected by uncontrollable factors such as age, gender, race, and genetics, as well as controllable factors that include body weigh, diet, physical activity, and smoking.



- Nutritional intervention is an important and contributing factor in reducing the progression of the disease and preventing the emergence of complications related to DM.
- The dietary practices of people with DM are influenced by the extent of their education and knowledge of appropriate for DM.

Al-Adwi, et al. Nutrition and Health. 2022

Diet, Dietary Patterns and Physical Activity and DM

Open access Original research

BMJ Open

White rice, brown rice and the risk of type 2 diabetes: a systematic review and meta-analysis

Jiayue Yu,[1] Bhavadharini Balaji,[2] Maria Tinajero,[3] Sarah Jarvis,[3] Tauseef Khan,[3] Sudha Vasudevan,[4] Viren Ranawana,[5] Amudha Poobalan,[6] Shilpa Bhupathiraju,[7,8] Qi Sun,[8] Walter Willett,[8] Frank B Hu,[8] David J A Jenkins ,[3,9] Viswanathan Mohan,[10] Vasanti S Malik [3,8]

- In cohort studies, white rice was associated with higher risk of T2D (pooled RR, 1.16; 95%CI: 1.02 to 1.32).
- At intakes above ~300g/day, a dose–response was observed (each 158g/day serving was associated with 13% (11%–15%) higher risk of T2D).
- Intake of brown rice was associated with lower risk of T2D (pooled RR, 0.89; 95%CI: 0.81 to 0.97).

- Each 50g/day serving of **brown rice** was associated with 13% (6%–20%) lower risk of T2D.

- RCTs showed an increase in HDL (0.06mmol/L; 0.00 to 0.11mmol/L) in the brown compared with white rice group.

nutrients

Review

The Potential of the Mediterranean Diet to Improve Mitochondrial Function in Experimental Models of Obesity and Metabolic Syndrome

Mohamad Khalil [1,2], Harshitha Shanmugam [1], Hala Abdallah [1], Jerlin Stephy John Britto [1], Ilaria Galerati [1], Javier Gómez-Ambrosi [3,4,5], Gema Frühbeck [3,4,5,6] and Piero Portincasa [1,*]

Mediterranean Diet (MD)

- It is observed that many obesity-related cardiometabolic disorders can influence the function and energetic capacity of mitochondria.
- Mediterranean diet (MD) can improve dysfunctional mitochondria in obesity and CMDs.


Weekly
Sweets ≤ 2 s
Potatoes ≤ 3 s
Red meat < 2 s
Processed meat ≤ 1 s
White meat 2 s
Fish/seafood ≥ 2 s
Eggs 2–4 s
Legumes ≥ 2 s
Every day
Dairy 2 s
(preferably low fat)
Olives/nuts/seeds 1–2 s
Herbs/spices/garlic/onions
(less added salt)
Variety of flavours
Every main meal
Fruits 1–2 | vegetables ≥ 2 s
Variety of colour/textures
(cooked/raw)
Olive oil
Bread/pasta/rice/couscous/
Other cereals 1–2 s
(preferably whole grain)
Water and herbal
infusions
Regular physical activity
Adequate rest
Conviviality
Biodiversity and seasonality
Traditional, local
and eco-friendly products
Culinary activities
2010 edition
s = Serving

- **The term "Mitochondria nutrients" has been adopted in recent years, and it depicts the adequate nutrients to keep proper mitochondrial function.**

- **Different experimental models show that components of the MD, including minerals magnesium, polyphenols, plant-derived compounds, and polyunsaturated fatty acids, can improve mitochondrial metabolism, biogenesis, and antioxidant capacity.**

- For example, hydroxytyrosol, a polyphenol from olive oil, was effective in the regulation of multiple high fat diet-induced MetS, especially those related to mitochondrial dysfunction, through the modulation of mitochondrial apoptotic pathway in the liver and skeletal muscles.

Table 2. Principal features of Western diet, Vegan diet, and Mediterranean diet.

	Western Diet	Vegan Diet	Mediterranean Diet
Characteristics	High fat and sugar	High vegetable Low fat No meat	Low meat High vegetable and olive oil High plant-based foods
Main components	Red meat (Saturated fat and cholesterol) Refined grains Fructose beverage	Fiber Grain Cereals	Fiber Antioxidants Unsaturated fats Whole grain
Health consequences	Obesity Insulin resistance NAFLD Diabetes CVD	Healthy (if balanced) Deficiency of essential macro and micronutrients (if unbalanced)	Healthy

	Western Diet	Vegan Diet	Mediterranean Diet
Mechanisms	↑ Adipose tissue ↑ Circulating FFAs ↑ Hepatic lipid accumulation ↑ Triglycerides ↑ Cholesterol ↑ Fasting glucose ↑ De novo lipogenesis ↑ VLDL ↑ ER stress ↑ Lysosomal permeabilization ↓ Insulin sensitivity	↓ Circulating FFAs ↓ Hepatic steatosis ↓ Lipolysis ↓ De novo lipogenesis ↑ Insulin sensitivity	↓ Circulating FFAs ↓ Hepatic steatosis ↓ Triglycerides ↓ Cholesterol ↓ Inflammation ↓ Lipolysis ↓ De novo lipogenesis ↓ ROS ↓ CRP ↑ Insulin sensitivity ↓ Inflammatory markers
Effect on Mitochondria	↑ mtROS ↓ mitochondrial biogenesis ↓ mitochondrial respiration	↓ mtROS ↑ mitochondrial biogenesis ↑ mitochondrial respiration	↓ mtROS ↑ mitochondrial biogenesis ↑ mitochondrial respiration
References	[188,190,191]	[189,192,193]	[194–199]

Abbreviation: **NAFLD**: non-alcoholic fatty liver disease, **CVD**: cardiovascular disease, **FFAs**: free fatty acids, **ROS**: reactive oxygen species, **CRP**: C-reactive protein, **mtROS**: mitochondrial reactive oxygen species, **ER**: endoplasmic reticulum, ↑: increased, ↓: decreased.

Association of Sedentary Behavior with DM

> Nutr Hosp. 2020 Apr 16;37(2):359-373. doi: 10.20960/nh.02740.

A systematic review of cross-sectional studies on the association of sedentary behavior with cardiometabolic diseases and related biomarkers in South American adults

Kliver Antonio Marin [1], Helen Hermana Miranda Hermsdorf [2], Fabiane Aparecida Canaan Rezende [1], Maria do Carmo Gouveia Peluzio [2], Antônio José Natali [2]

Affiliations + expand

PMID: 32054279 DOI: 10.20960/nh.02740

Abstract in English, Spanish

Introduction: sedentary behavior (SB) has been independently associated with detrimental health outcomes in different regions worldwide. The aim of this systematic review was to examine whether domain-specific SB is associated with cardiometabolic diseases (CMD) and related biomarkers in South American adults. Methods: nine electronic databases were searched to identify all studies that ...tion between SB and CMD-e.g. obesity, diabetes, hypertension, metabolic

Obesity in association with sedentary behavior

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Cortes et al. (2013) - Non-smokers	0.1	0.04	12.7%	1.11 [1.02, 1.20]
Cortes et al. (2013) - Smokers	0.53	0.2	6.3%	1.70 [1.15, 2.51]
Fernandes et al. (2010) - Men	-0.02	0.08	11.3%	0.98 [0.84, 1.15]
Fernandes et al. (2010) - Women	0.35	0.13	9.0%	1.42 [1.10, 1.83]
Garcia et al. (2014) - Men	0.24	0.05	12.4%	1.27 [1.15, 1.40]
Garcia et al. (2014) - Women	0.22	0.09	10.8%	1.25 [1.04, 1.49]
Martínez et al. (2018)	0.14	0.06	12.1%	1.15 [1.02, 1.29]
Petermann et al. (2017) - Men	0.68	0.16	7.7%	1.97 [1.44, 2.70]
Petermann et al. (2017) - Women	-0.13	0.12	9.5%	0.88 [0.69, 1.11]
Poterico et al. (2012)	0.96	0.15	8.2%	2.61 [1.95, 3.50]
Total (95% CI)			**100.0%**	**1.30 [1.14, 1.49]**

Heterogeneity: $Tau^2 = 0.04$; $Chi^2 = 60.51$, df = 9 ($P < 0.00001$); $I^2 = 85\%$
Test for overall effect: Z = 3.84 (P = 0.0001)

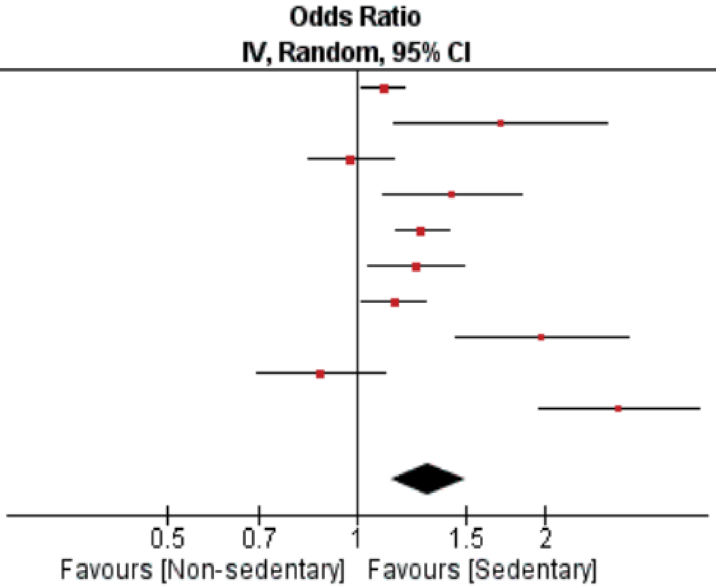


Figure 2.
Pooled odds ratios for obesity in association with sedentary behavior. (CI: confidence interval; SE: standard error. Source: prepared by the authors from the study results).

Diabetes in association with sedentary behavior

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Diaz-Martinez et al. (2017) - Men	0.1	0.03	24.2%	1.11 [1.04, 1.17]
Diaz-Martinez et al. (2017) - Women	0.08	0.03	24.2%	1.08 [1.02, 1.15]
Garcia et al. (2014) - Men	0.06	0.09	11.4%	1.06 [0.89, 1.27]
Garcia et al. (2014) - Women	-0.15	0.14	6.2%	0.86 [0.65, 1.13]
Lemes et al. (2018)	0.47	0.2	3.4%	1.60 [1.08, 2.37]
Martínez et al. (2018)	0.24	0.09	11.4%	1.27 [1.07, 1.52]
Silva et al. (2015)	0.3	0.13	6.9%	1.35 [1.05, 1.74]
Werneck et al. (2018) - Men	0.49	0.25	2.3%	1.63 [1.00, 2.66]
Werneck et al. (2018) - Women	0.29	0.1	10.0%	1.34 [1.10, 1.63]
Total (95% CI)			**100.0%**	**1.16 [1.07, 1.25]**

Heterogeneity: Tau² = 0.01; Chi² = 17.88, df = 8 (P = 0.02); I² = 55%
Test for overall effect: Z = 3.69 (P = 0.0002)

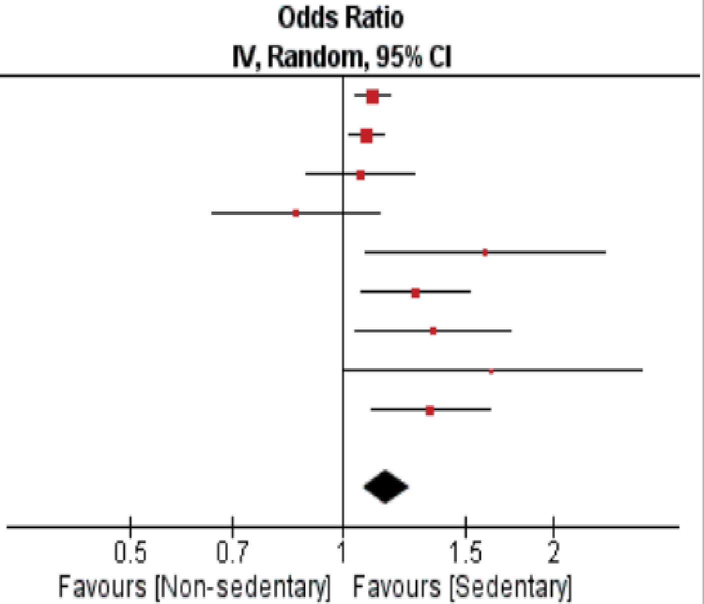


Figure 3.
Pooled odds ratios for diabetes in association with sedentary behavior. (CI: confidence interval; SE: standard error. Source: prepared by the authors from the study results).

Long time spent in sedentary behavior, mainly sitting and TV time, **was positively associated with the occurrence of DM and CVD** and related biomarkers in South American adults.

Studies revealed that **the type and composition of the diet** could play a role in the management of DM.

Al-Adwi, et al. Nutrition and Health. 2022

Nutrients Contents and DM

Journal of Obesity & Metabolic Syndrome 2022;31:100-122
https://doi.org/10.7570/jomes22009

pISSN 2508-6235
eISSN 2508-7576

Review

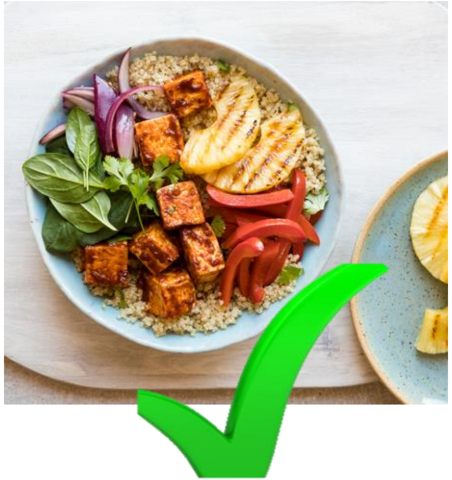
Effect of Carbohydrate-Restricted Diets and Intermittent Fasting on Obesity, Type 2 Diabetes Mellitus, and Hypertension Management: Consensus Statement of the Korean Society for the Study of Obesity, Korean Diabetes Association, and Korean Society of Hypertension

Jong Han Choi[1], Yoon Jeong Cho[2], Hyun-Jin Kim[3], Seung-Hyun Ko[4], Suk Chon[5], Jee-Hyun Kang[6], Kyoung-Kon Kim[7], Eun Mi Kim[8], Hyun Jung Kim[9], Kee-Ho Song[1,*], Ga Eun Nam[10,*], Kwang Il Kim[11,*], Committee of Clinical Practice Guidelines, Korean Society for the Study of Obesity (KSSO), Committee of Clinical Practice Guidelines and Committee of Food and Nutrition, Korean Diabetes Association (KDA), Policy Committee of Korean Society of Hypertension (KSH), Policy Development Committee of National Academy of Medicine of Korea (NAMOK)

Recommendations

- To reduce body weight in adults with overweight or obesity, **a balanced and high quality diet with carbohydrate restriction and reduced caloric intake is recommended.**
- Recent guidelines for obesity and DM management allow the individualized use of **carbohydrate-restricted diets for obesity treatment**, and most of the **carbohydrate-restricted diets included in this study involved a decrease in total calorie intake**.

- In a cohort study examining the association between a carbohydrate-restricted diet and the mortality risk, an animal product-based carbohydrate-restricted diet was associated with increased all-cause mortality both in men and women.
- In contrast, a vegetable-based carbohydrate-restricted diet was associated with reduced all-cause mortality.



Other studies showed that:

- High amounts of fatty and sugary food would lead to obesity.
- Vegetables and fruits intake, on the other hand, protects against T2DM development.
- Low intake of refined carbohydrate or low-fat eating plan could contribute to the prevention of T2DM onset.
- Low-salt diet can reduce high blood pressure, which is common in patients with T2DM.

Al-Adwi, et al. Nutrition and Health. 2022

The majority of studies have shown that simple carbohydrates, fats, and salt intakes are associated with poor glycemic control Kheriji, et al, Nutrients 2022, 14, 2132.

However, there is a lack of research on how diet composition and type can affect glycemic control (HbA1c <7.0) of adults who have diabetes and are living in Qatar.

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THE STUDY AIM:

Therefore, our secondary analysis study intended to explore the potential association between various diets adopted by adults with diabetes who are living in Qatar with their glycemic control.

methods

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Study Population:

- Participants' data was obtained from Qatar Biobank (QBB) for secondary analysis.
- The study population included 2,448 adults (females: 1,448; and males: 1,000) Qatari and long-term residents (≥15 years) from 18 to 70 years of age with DM.
- Pregnant women and patients with terminating illnesses were excluded.

- Participants were classified into two groups: the first, which included DM participants with good glycemic control (HbA1c <7%), while the second group included participants with poor glycemic control (HbA1c ≥7%).

- Face-to-face interviews with the patients were conducted with the assistance of professional nurses to gather information about their health status, dietary habits and patterns, medical history, and medication use.

Methods

- **Anthropometric data:** weight (Kg), height (m), waist circumference (cm), hip circumference (cm).
- **Biochemical:** HbA1c (%).
- **Different types of diets:** low-fat diet, low-calorie diet, low-salt diet, and regular diet.
- A qualitative **food frequency questionnaire** was used to provide data.
- QBB data collection and sample recruitment protocols were **approved** by the Hamad Medical Corporation Ethics Committee.
- The current analysis was approved under the **IRB exempted category (QF-QBB-RES-ACC-00058).**

Dependent Variable

- Glycemic control

Independent Variables

- Low-fat diet
- Low-calorie diet
- Low-salt diet
- Regular diet
- More than diet

Covariates

Age, gender BMI and smoking status

Education levels

- Education levels were divided into three categories: **lower education** (up to secondary school), **medium education** (technical or professional school), and **higher education** (university and above).

The physical activity levels

- The physical activity levels were assessed in **hours per week using the International Physical Activity Questionnaire.**

Statistical Analysis

- SPSS Inc. was used to analyze data.
- Data were presented as mean ± SD and frequency.
- Binary regressions were used to assess the association between glycemic control and the five mentioned diets.
- This association was adjusted for four models:
  - Model 1 is adjusted for gender, age, and comorbidities;
  - Model 2 for gender, age, sociodemographic, and comorbidities;
  - Model 3 for gender, age, sociodemographic, anthropometric, and comorbidities; and
  - Model 4 for gender, age, sociodemographic, anthropometric, dietary habits, and physical activity, comorbidities, and medications.
- The statistical significance level was set as P-value ≤0.05.


RESULTS

Variable	Patients with HbA1C ≥ 7%				
	Regular (n = 959)	Low-calorie diet (n = 162)	Low-salt diet (n = 89)	Low-fat diet(n = 169)	More than one diet (n = 127)
	Mean ± SD				
Age (year)	53.4 ± 11.2	51.5 ± 11.4	54.4 ±12.1	52.9 ±13.7	52.7 ±12.8
Weight (Kg)	85.0 ±16.3	86.0 ±20.1	89.0 ±17.3	81.8 ±13.3	84.8 ±17.1
Height (cm)	161.9 ±9.4	161.0 ±9.3	162.2 ± 10.5	163.0 ±9.3	164.3 ± 9.9
Body mass index (Kg/m²)	32.5 ±6.0	33.1 ±6.7	33.6 ± 4.1	30.9 ±5.0	31.3 ± 5.5
Waist Circumference (cm)	99.8 ±12.2	99.6 ±15.1	103.8 ± 13.5	96.6 ±12.4	99.5 ±13.7
Hip Circumference (cm)	109.4 ±12.2	110.3± 13.1	112.1 ±9.3	107.4 ±9.9	107.9 ± 13.1
HbA1C %	8.8 ±1.6	8.6 ±1.4	8.6 ±1.8	8.5 ±1.2	8.7 ±1.7

Variable	Patients with HbA1C < 7%				
	Regular (n = 847)	Low-calorie diet (n = 182)	Low-salt diet (n = 92)	Low-fat diet (n = 204)	More than one diet (n = 133)
	Mean ± SD				
Age (year)	50.1 ± 12.	47.8 ± 10.7	55.2 ± 12.8	51.7 ± 11.0	52.1 ±11.7
Weight (Kg)	82.8 ±6.2	84.1 ± 15.0	77.9 ± 13.1	82.6 ±12.2	80.9 ±13.7
Height (cm)	161.2 ± 9.3	161.6 ±9.7	158.0 ± 6.6	160.7 ±8.5	163.0 ±9.5
Body mass index (Kg/m²)	32.0 ±6.1	32.2 ±5.3	31.3 ± 5.5	32.1 ±4.7	30.5 ±5.0
Waist Circumference (cm)	95.1 ±12.5	95.0 ± 12.3	91.7 ± 13.2	94.7 ±11.8	94.2 ±11.3
Hip Circumference (cm)	109.7 ± 12.1	110.3 ± 10.8	107.0 ± 9.1	110.2 ±10.3	107.5 ±9.9
HbA1C %	6.1 ±0.6	6.0 ±0.5	5.6 ± 1.1	6.1 ±0.6	6.1 ±0.6

Variables	Patients with HbA1C ≥7%					Patients with HbA1C <7%				
	Regular (*n* = 959)	Low-calorie diet (*n* = 162)	Low-salt diet (*n* = 89)	Low-fat diet (*n* = 169)	More than one diet (*n* = 127)	Regular (*n* = 847)	Low-calorie diet (*n* = 182)	Low-salt diet (*n* = 92)	Low-fat diet (*n* = 204)	More than one diet (*n* = 133)
	n (%)					*n* (%)				
Diet modification within last year (Yes)	223(23.20)	119(73.5)	62 (69.7)	125 (74)	90(70.90)	273(31.90)	143(78.6)	65 (70.7)	148 (72.5)	100(75.20)
How often during a typical week in the last year did you eat from a common plate, shared with others?										
•Every day	350 (36.5)	38 (23.5)	24 (27)	40 (23.7)	34 (26.8)	301 (35.6)	38 (20.9)	16 (17.4)	41 (20.1)	26 (19.5)
•>3 times/week	141 (14.7)	32 (19.8)	17 (19.1)	32 (18.9)	21 (16.5)	118 (14.0)	34 (18.7)	15 (16.3)	38 (18.6)	24 (18.0)
•1-3 times /week	140 (14.6)	31 (19.1)	14 (15.7)	39 (23.1)	26 (20.5)	155 (18.3)	57 (31.3)	21 (22.8)	46 (22.5)	31 (23.3)
•1/month	98 (10.2)	24 (14.8)	13 (14.6)	23 (13.6)	16 (12.6)	94 (11.1)	16 (8.8)	15 (16.3)	32 (15.7)	19 (14.3)
•Never or rarely	229 (23.9)	37 (22.8)	21 (23.6)	35 (20.7)	30 (23.6)	177 (20.9)	37 (20.3)	25 (27.2)	47 (23)	33 (24.8)
How often, during a typical week in the last year, did you eat food from home-delivery, take-away, or fast-food restaurants?										
• <1/week	220 (23.0)	37 (22.8)	14 (15.7)	38 (22.5)	25 (19.7)	181(21.4)	49 (26.9)	26 (28.3)	54 (26.5)	37 (27.8)
•1–2/week	176 (18.4)	30 (18.5)	9 (10.1)	27 (16.0)	20 (18.0)	178 (21.0)	40 (22.0)	15 (16.3)	40 (19.6)	28 (21.1)
•3–5 times/week	76 (7.9)	11 (6.8)	6 (6.7)	8 (4.7)	8 (3.6)	81 (9.6)	10 (5.5)	5 (5.4)	11 (5.4)	7 (5.3)
•Every day or almost everyday	16 (1.7)	3 (1.9)	1 (1.1)	1 (0.6)	1 (0.8)	32 (3.8)	2 (1.1)	1 (1.1)	2 (1.0)	1 (0.8)
•Never or rarely	470 (49.1)	81 (50.0)	59 (66.3)	95 (56.2)	73 (57.5)	375 (44.3)	81 (44.5)	45 (48.9)	97 (47.5)	60 (45.1)

Variables	Patients with HbA1C ≥7%					Patients with HbA1C <7%				
	Regular (*n* = 959)	Low-calorie diet (*n* = 162)	Low-salt diet (*n* = 89)	Low-fat diet (*n* = 169)	More than one diet (*n* = 127)	Regular (*n* = 847)	Low-calorie diet (*n* = 182)	Low-salt diet (*n* = 92)	Low-fat diet (*n* = 204)	More than one diet (*n* = 133)
	n (%)					*n* (%)				
How often of eating snacks between meals in typical week in the last year (Meals: breakfast, lunch, and dinner)?										
•>7 times / week	118 (12.3)	26 (16.0)	10 (11.2)	22 (13.0)	18 (14.2)	121 (14.3)	27 (14.8)	10 (10.9)	23 (11.3)	13 (9.8)
•6–7 times per week	168 (17.5)	25 (15.4)	14 (15.7)	29 (17.2)	21 (16.5)	134 (15.8)	29 (15.9)	13 (14.1)	36 (17.6)	26 (19.5)
•One or twice per week	259 (27.0)	32 (19.8)	21 (23.6)	38 (22.5)	25 (19.7)	223 (26.3)	31 (17.0)	18 (19.6)	44 (21.6)	24 (18.0)
•3-5 times a week	182 (19.0)	39 (24.1)	22 (24.7)	44 (26.0)	33 (26.0)	152 (17.9)	61 (33.5)	29 (31.5)	58 (28.4)	43 (32.3)
•Prefer not to answer	232(24.2)	40 (24.7)	22 (24.7)	36 (21.3)	30(23.6)	217(25.6)	34 (18.7)	22 (23.9)	43 (21.1)	27(20.3)

Variables	Patients with HbA1C ≥7%					Patients with HbA1C <7%				
	Regular (*n* = 959)	Low-calorie diet (*n* = 162)	Low-salt diet (*n* = 89)	Low-fat diet (*n* = 169)	More than one diet (*n* = 127)	Regular (*n* = 847)	Low-calorie diet (*n* = 182)	Low-salt diet (*n* = 92)	Low-fat diet (*n* = 204)	More than one diet (*n* = 133)
	n (%)*					*n* (%)*				
The level of activity involved:										
•Sitting most of the time	417 (45.7)	58 (36.9)	27 (31.8)	57 (35.6)	42 (33.1)	341 (41.1)	76 (43.4)	33 (37.1)	83 (41.9)	55 (41.4)
•Standing most of the time	17 (1.9)	4 (2.5)	1 (1.2)	3 (1.9)	2 (1.6)	13 (1.6)	6 (3.4)	2 (2.2)	2 (1.0)	3 (2.3)
•Sitting, standing, and walking in equal amounts	346 (37.9)	67 (42.7)	44 (51.8)	75 (46.9)	54 (42.6)	350 (42.2)	63 (36.0)	40 (44.9)	76 (38.4)	50 (37.6)
•Walking most of the time	36 (3.9)	14 (8.9)	4 (4.7)	12 (7.5)	9 (7.1)	33 (4.0)	6 (3.4)	4 (4.5)	13 (6.6)	5 (3.8)
•Other work with moderate physical activity (includes moving or lifting objects of moderate weight)	59 (6.5)	12 (7.6)	7 (8.2)	9 (5.6)	9 (7.1)	63 (7.6)	19 (10.9)	5 (5.6)	14 (7.1)	9 (6.8)
•Physically heavy work (includes moving or lifting heavy objects or activities)	4 (0.4)	1 (0.6)	1 (1.2)	3 (1.9)	2 (1.6)	7 (0.8)	3 (1.7)	2 (2.2)	4 (2.0)	3 (2.3)

Table 3: Association between types of diets and other variables with glycemic control based on HbA1c.

Binary logistic regression (model 1: adjusted for gender, age and comorbidities)		
Variables	OR(95%CI)	*P*-value
Gender	1.56(1.32–1.84)	<0.001
Age	0.98(0.97–0.98)	<0.001
Regular diet	1.00(0.67–1.49)	1
Low-calorie diet	1.34(0.84–2.14)	0.22
Low-salt diet	1.67(0.94–2.98)	0.08
Low-fat diet	1.86(1.11–3.11)	0.02
More than one diet	0.67(0.49–0.92)	0.01
Dyslipidemia	1.00(1.00–1.00)	0.41
Hypertension	1.00(1.00–1.00)	0.53
Constant	1.47	0.19

Binary logistic regression (model 2: adjusted for, age, gender, sociodemographic, and comorbidities)		
Variables	OR(95%CI)	*P*-value
Gender	1.69(1.384–2.065)	<0.001
Age	0.98(0.974–0.989)	<0.001
Regular diet	1.03(0.688–1.543)	0.89
Low-calorie diet	1.33(0.834–2.133)	0.23
Low-salt diet	1.68(0.940–2.993)	0.08
Low-fat diet	**1.85(1.103–3.107)**	**0.02**
More than one diet	**0.67(0.48–0.92)**	**0.01**
Dyslipidemia	1.00(1.00–1.00)	0.42
Hypertension	1.00(1.00–1.00)	0.53
Income	1.00(1.00–1.00)	0.67
Educational level	1.07(1.03–1.12)	<0.001
Smoking	1.01(0.94–1.10)	0.74
Constant	0.7	0.35

Binary logistic regression (model 3: adjusted for age, gender, sociodemographic, anthropometric, and comorbidities)

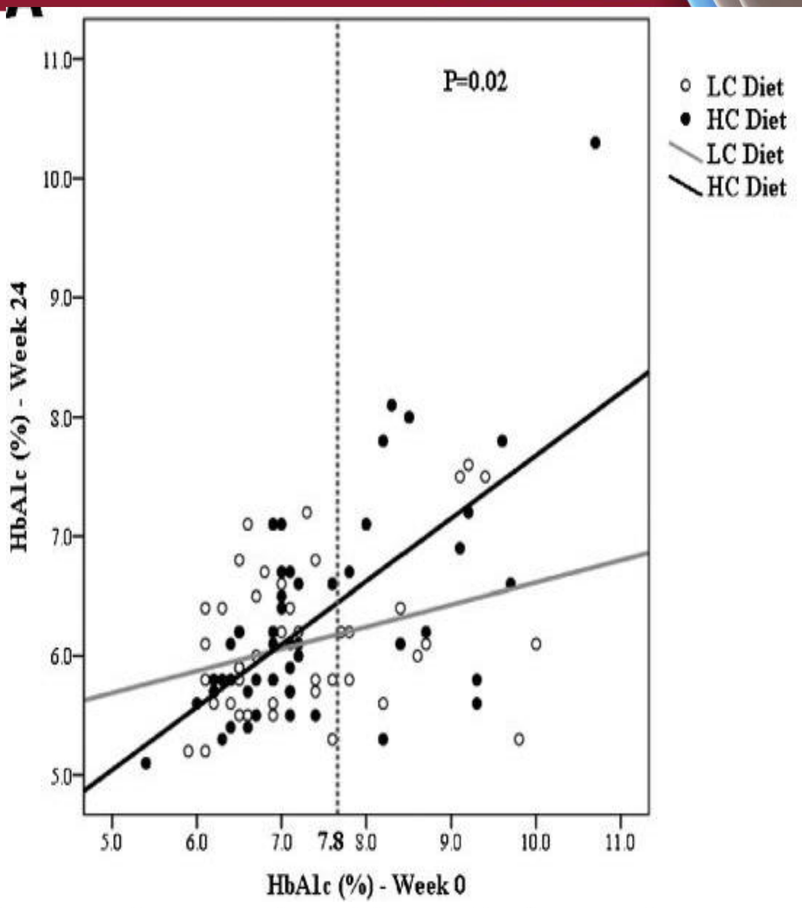
Variables	OR(95%CI)	*P*-value
Gender	1.83(1.49–2.25)	<0.001
Age	0.98(0.97–0.99)	<0.001
Regular diet	1.03(0.69–1.54)	0.89
Low-calorie diet	1.33(0.83–2.13)	0.24
Low-salt diet	**1.75(1.18–3.14)**	**0.05**
Low-fat diet	**1.81(1.07–3.03)**	**0.03**
More than one diet	**0.66(0.48–0.91)**	**0.01**
Dyslipidemia	1.00(1.00–1.00)	0.38
Hypertension	1.00(1.00–1.00)	0.52
Educational level	1.07(1.02–1.11)	<0.001
Income	1.00(1.00–1.00)	0.72
BMI	0.98(0.96–0.99)	0.01
Smoking	1.02(0.94–1.10)	0.64
Constant	1.29	0.57

Binary logistic regression (model 4:adjusted for age, gender, sociodemographic, anthropometric, dietary habits and physical activity OR lifestyle habits, comorbidities, and medications)

Variables	OR(95%CI)	*P*-value
Gender	1.96(1.56–2.45)	<0.001
Age	0.99(0.98–1.00)	0.1
Regular diet	1.07(0.68–1.69)	0.76
Low-calorie diet	1.30(0.77–2.20)	0.32
Low-salt diet	1.90(1.00–3.63)	0.05
Low-fat diet	1.73(1.06–3.07)	0.05
More than one diet	0.69(0.48–0.99)	0.04
Dyslipidemia	1.00(1.00–1.00)	0.73
Hypertension	1.00(1.00–1.00)	0.71
Educational level	1.02(0.98–1.07)	0.34
Income	1.00(1.00–1.00)	0.79
BMI	0.98(0.96–0.99)	0.01
Smoking	1.03(0.94–1.12)	0.53
Eating from common plate	1.00(0.95–1.06)	0.89
Use of hypoglycemic drugs	0.35(0.28–0.44)	<0.001
Insulin Use	0.12(0.09–0.15)	<0.001
Physical activity	1.00(1.00–1.00)	0.8
Constant	2.25	0.1

Low-fat diet:

A study comparing the effect of **high-unrefined carbohydrate, low-fat diet (HC)** on glycemic control with those of a **very low-carbohydrate, and high-unsaturated/low-saturated fat diet (LC)** found that both energy-reduced LC and HC diets with low-saturated fat content produce ***significant improvements in glycemic control*** in adults with T2DM. **Glycemic control was greatest with the LC compared with HC.** *(Tay et al Diabetes Care. (2014) 37:2909–18.)*

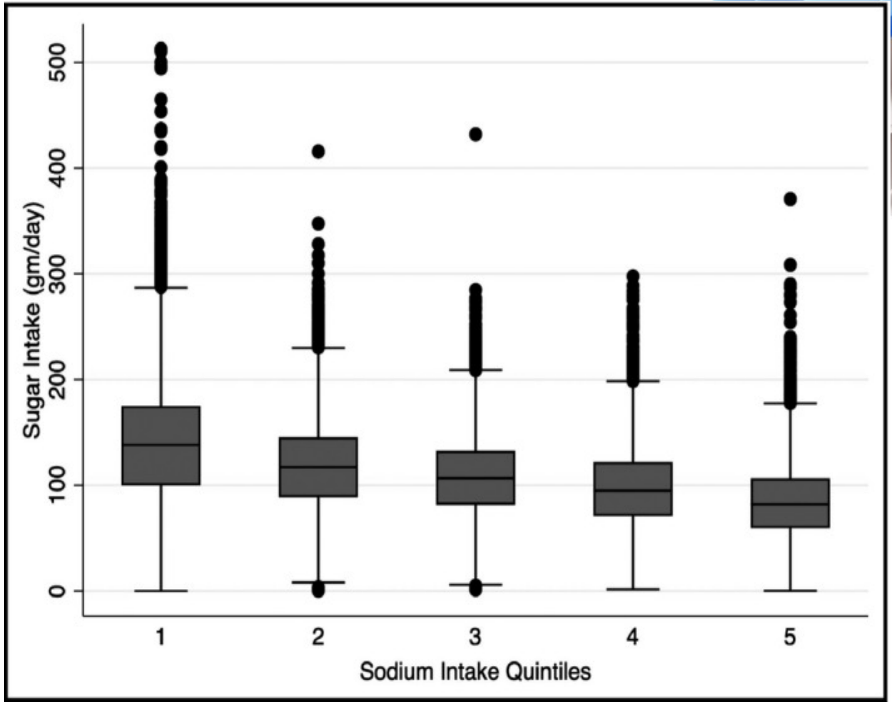


Low-Salt Diet

- The present study showed an increase in the risk of poor glycemic control for patients, who were following a low-salt diet.
- Salt restriction increases insulin resistance, which increases blood glucose levels and, thus, HbA1c.
- Short term sodium restriction stimulates the sympathetic nervous system to increase the production of blood catecholamine concentrations, thus, increasing insulin resistance.

Oh et al. Clin Nutr Res. (2016) 5:1–6.

- **Gress et al. revealed that low sodium intake based on 24-h dietary recall was accompanied by a higher consumption of sugar.**
- **The negative impact of a low sodium diet on glycemic control may be explained at least partially by the associated high sugar intake.**



Gress et al (2020). Journal of clinical hypertension, (22(9), 1694–1702

- The combination of two or more diets has been found to reduce the likelihood of poor glycemic control.

- This effect may be due to the combined benefits of a low-calorie diet and either a low-salt or low-fat diet, which can enhance the positive impact of each diet individually.

The limitations and strengths

- The main limitation is the determination of the diet type, which was based on the food choices and the participant's perception of his/her diet as compared to before diagnosis.
- However, this study has several strengths.
  - First, the sample size is a total of 2,448 participants, which represents a large number of the Qatari population.
  - Secondly, the sample size is homogeneous since all patients are of Qatari nationality or have had a long-term residency in Qatar.

CONCLUSION

The results of this secondary analysis indicated that patients who followed *multiple diets* had better glycemic control compared to those who followed only a *low-calorie, low-salt, or low-fat diet*.

Following *low-fat* diet or *low-salt* diet only could be associated with poor glycemic control.

Longitudinal studies are needed to confirm our results.


thank
you

TABLE 1 | Characteristics of the study sample by diet type.

Variable	Patients with HbA1C ≥ 7%				
	Regular ($n = 959$)	Low-calorie diet ($n = 162$)	Low-salt diet ($n = 89$)	Low-fat diet($n = 169$)	More than one diet ($n = 127$)
			Mean ± SD		
Age (year)	53.4 ± 11.2	51.5 ± 11.4	54.4 ±12.1	52.9 ±13.7	52.7 ±12.8
Weight (Kg)	85.0 ±16.3	86.0 ±20.1	89.0 ±17.3	81.8 ±13.3	84.8 ±17.1
Height (cm)	161.9 ±9.4	161.0 ±9.3	162.2 ± 10.5	163.0 ±9.3	164.3 ± 9.9
Body mass index (Kg/m²)	32.5 ±6.0	33.1 ±6.7	33.6 ± 4.1	30.9 ±5.0	31.3 ± 5.5
Waist Circumference (cm)	99.8 ±12.2	99.6 ±15.1	103.8 ± 13.5	96.6 ±12.4	99.5 ±13.7
Hip Circumference (cm)	109.4 ±12.2	110.3± 13.1	112.1 ±9.3	107.4 ±9.9	107.9 ± 13.1
HbA1C %	8.8 ±1.6	8.6 ±1.4	8.6 ±1.8	8.5 ±1.2	8.7 ±1.7
			n* (%)		
Age group (year):					
• 18–30	33 (3.4)	12 (7.4)	4 (4.5)	16 (9.5)	12 (9.4)
• 31–50	322 (33.6)	50 (30.9)	17 (19.1)	39 (23.1)	28 (22.0)
• 51–70	552 (57.6)	92 (56.8)	61 (68.5)	103 (60.9)	80 (63.0)
• 70	52 (5.4)	8 (4.9)	7 (7.9)	11 (6.5)	7 (5.5)
Gender					
• Male	432(45.0)	83(51.2)	49(55.1)	89(52.7)	73(57.5)
• Female	527(55.0)	79(48.8)	40(44.9)	80(47.3)	54(42.5)
Smoking					
• No, have never smoked	650 (67.8)	97 (59.9)	52 (58.4)	98 (58)	69 (54.3)
• Yes, on most or all days	85 (8.9)	8 (4.9)	7 (7.9)	13 (7.7)	10 (7.9)
• Yes, only occasionally	34 (3.5)	13 (8.0)	5 (5.6)	11 (6.5)	9 (7.1)
• No, stopped smoking	107 (11.2)	25 (15.4)	17 (19.1)	26 (15.4)	23 (18.1)

Variable	Patients with HbA1C < 7%				
	Regular (*n* = 847)	Low-calorie diet (*n* = 182)	Low-salt diet (*n* = 92)	Low-fat diet (*n* = 204)	More than one diet (*n* = 133)
	Mean ± SD				
Age (year)	50.1 ± 12.	47.8 ± 10.7	55.2 ± 12.8	51.7 ± 11.0	52.1 ±11.7
Weight (Kg)	82.8 ±6.2	84.1 ± 15.0	77.9 ± 13.1	82.6 ±12.2	80.9 ±13.7
Height (cm)	161.2 ± 9.3	161.6 ±9.7	158.0 ± 6.6	160.7 ±8.5	163.0 ±9.5
Body mass index (Kg/m²)	32.0 ±6.1	32.2 ±5.3	31.3 ± 5.5	32.1 ±4.7	30.5 ±5.0
Waist Circumference (cm)	95.1 ±12.5	95.0 ± 12.3	91.7 ± 13.2	94.7 ±11.8	94.2 ±11.3
Hip Circumference (cm)	109.7 ± 12.1	110.3 ± 10.8	107.0 ± 9.1	110.2 ±10.3	107.5 ±9.9
HbA1C %	6.1 ±0.6	6.0 ±0.5	5.6 ± 1.1	6.1 ±0.6	6.1 ±0.6
	n (%)*				
Age group (year):					
• 18–30	57 (6.7)	12 (6.6)	5 (5.4)	9 (4.4)	7 (5.3)
• 31–50	351 (41.2)	86 (47.3)	25 (27.2)	82 (40.2)	50 (37.6)
• 51–70	413 (48.5)	78 (42.9)	57 (62)	103 (50.5)	69 (51.9)
• 70	31 (3.6)	6 (3.3)	5 (5.4)	10 (4.9)	7 (5.3)
Gender					
• Male	306(35.9)	64(35.2)	46(50)	76(37.3)	56 (42.7)
• Female	546(64.1)	118(64.8)	46(50)	128(62.7)	75 (57.3)
Smoking					
• No, have never smoked	600 (70.4)	125 (68.7)	54 (58.7)	127 (62.3)	78 (59.5)
• Yes, on most or all days	71 (8.3)	10 (5.5)	9 (9.8)	18 (8.8)	12 (9.2)
• Yes, only occasionally	23 (2.7)	16 (8.8)	5 (5.4)	9 (4.4)	10 (7.6)
• No, stopped smoking	69 (8.1)	14 (7.7)	9 (9.8)	14 (6.9)	10 (7.6)