Original Article

Diets for South Asians with diabetes: recommendations, adherence, and outcomes

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Background and Objectives: To determine how frequently diabetic diets are recommended to individuals with diabetes in South Asia, whether they are followed, and if they are associated with healthier dietary choices and clinical benefits. **Methods and Study Design:** Data are from the Centre for cArdiometabolic Risk Reduction in South-Asia Cohort Study. Participants with self-reported physician-diagnosed diabetes (n=1849) were divided into four groups based on whether they reported being prescribed and/or were following a diabetic diet. Linear regression was used to estimate associations between these groups and outcomes. **Results:** 53% of participants with self-reported diabetes reported not being prescribed or following a diabetic diet. Among those prescribed and following a diet, mean whole grain consumption was 1.18 times/day and refined grain consumption was 0.75 times/day compared to 0.88 times/day and 1.74 times/day, respectively, among those neither prescribed nor following a diet (both $p<0.0001$). Following a diet despite not being prescribed a diet was not associated with glycemic control, blood pressure, or body mass index, but was associated with a -8.54 mg/dL (95% confidence interval: -15.5, -1.58) lower low-density lipoprotein cholesterol compared to not following and not being prescribed a diet after adjustment for confounders. **Conclusion:** Though participants who were prescribed diabetic diets and followed them exhibited healthier dietary choices, the majority of participants with diabetes in urban South Asia was neither prescribed nor followed such diets. Moreover, there was no statistically significant clinical benefit, thus indicating that current dietary modifications may not be large enough or consistent enough to produce meaningful changes in health outcomes in this population.

Key Words: type 2 diabetes mellitus, India, Pakistan, lifestyle modifications, secondary prevention

INTRODUCTION

The prevalence of diabetes has been rising globally in recent years, particularly in South Asia. Today, 18% (approximately 76.2 million people) of individuals living with diabetes in the world reside in India and Pakistan.[1] The prevalence of diabetes in India and Pakistan in 2015 was 9.3% and 8.1%, respectively, and these numbers are predicted to reach 10.1% and 8.4% in the next 25 years.[1] Complications of diabetes exacerbate the already substantial economic burden experienced in this rapidly developing region.[2] Lifestyle changes including diet, physical activity, and weight management are considered first-line approaches to preventing such complications.[3-5]

Evidence from randomized controlled trials such as the Look AHEAD (Action for Health in Diabetes) Study suggests that diabetic diets can improve glycemic control and reduce the need for pharmacologic therapy,[6] yet their implementation, particularly in South Asia, has not been

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well studied. While there have been a limited number of studies performed in South Asia looking at adherence to diabetic diets and differences in nutrient or food group intake, they have either been restricted to specific states, cities, or hospitals or only involved individuals admitted to specialized endocrinology clinics where care received may not have been representative of care provided to the general population.[7-12]

Nonetheless, results to date suggest that implementation of diabetic diets in clinical practice in South Asia is challenging for several reasons including, for example, limited nutrition knowledge among patients;[13-16] lack of patient-centered, context-specific nutrition recommendations;[17] and difficulty accessing healthy alternatives, for example, in the case of white versus brown rice.[18,19] In a study of 258 patients with diabetes in New Delhi, 27% were not sure of the definition of a “simple carbohydrate,” and among those who reported that they knew, in a multiple choice question, 52% said that simple carbohydrates were “those digested quickly that are converted rapidly into sugar” and 48% said simple carbohydrates were “those digested slowly that are converted slowly into sugar” – about the proportion you would expect by chance alone.[15] Another example, STARCH (Study To Assess the dietary Carbohydrate content of Indian type 2 diabetes population), involving 796 patients with diabetes across 10 sites in India found that the two most common reasons for non-adherence to prescribed diabetic diets were “not being bothered about the suggested diet plan” and “not liking the advised diet.”[12] In a study of 654 patients with poorly controlled diabetes in Lucknow, 13% stated that the reason they chose their physician was that s/he did not insist on diet restrictions and exercise.[16] In a study of 200 patients with diabetes in Tamil Nadu, only 29% demonstrated “good dietary behavior” despite “reasonably good” access to healthcare.[7]

Together, these results suggest that factors other than access to care may be influencing adherence to diabetic diets in South Asia, and that more research is needed on representative, more generalizable cohorts of patients with diabetes. There have been no population-based studies of prescription and adherence to diabetic diets in South Asia. It remains unclear how frequently physicians recommend diabetic diets, whether or not individuals with diabetes follow them, or if they are associated with clinical benefits. The aim of this study was to address these gaps using data from a population-based study in urban South Asia.

PARTICIPANTS AND METHODS

Subjects

Data were from the Centre for cArdiometabolic Risk Reduction in South-Asia (CARRS) Cohort Study. The CARRS Cohort Study used complex, multi-stage, probability-based sampling to select households and individuals that were representative of the cities involved (Chennai and New Delhi in India, and Karachi in Pakistan). A total of 16,287 men and non-pregnant women over 20 years old were enrolled in 2010-11.[20] The baseline study visit involved a comprehensive questionnaire that covered socio-demographics, medical history, diet, and other lifestyle behaviors, as well as anthropometric measurements and fasting blood sample collection for laboratory analyses.

All procedures were approved by the ethics review committees at Emory University (IRB00044159), Public Health Foundation of India (IRB00006658), All India Institute of Medical Sciences (IEC/NP-17/07.09.09), Aga Khan University (1468-CHS-ERC-2010), and Madras Diabetes Research Foundation (IRB00002639). Written informed consent was obtained from all participants.

Exposure assessment

As part of the medical history, participants were asked whether a doctor had told them they had diabetes. We identified participants following diabetic diets by their response to a question that asked if they were on a special diet (Supplemental Online Material). Those who responded, ‘yes’, were further asked what diets they followed (‘diabetic diet’, ‘low-fat diet’, ‘high-fiber diet’, ‘low salt diet’, ‘weight-reducing diet’, or ‘other’). For this study, we considered ‘diabetic diet’, ‘high-fiber diet’, ‘low-fat diet’, and ‘weight-reducing diet’ as dietary modifications for diabetes (together hereafter referred to as ‘diabetic diets’). The study also queried whether or not participants with self-reported diabetes were ‘prescribed dietary modifications’ as a treatment for diabetes (‘yes’ or ‘no’) (Supplemental Online Material).

We classified participants with self-reported diabetes into four exposure groups based on whether they were prescribed dietary modifications and whether they reported following diabetic diets. The groups were as follows: (1) individuals who reported both being prescribed dietary modifications and following a diabetic diet, (2) individuals who reported being prescribed dietary modifications but not following a diabetic diet, (3) individuals who reported following a diabetic diet but not being prescribed dietary modifications, and (4) individuals who reported neither being prescribed dietary modifications nor following a diabetic diet.

Outcome assessments

Dietary intake

CARRS used a 26-item food propensity questionnaire, adapted from the INTERHEART study.[21] The food propensity questionnaire is not quantitative; thus, we could not calculate nutrient-level data and were limited to comparisons of the frequency of consumption of food groups.

Cardio-metabolic risk factors

We evaluated six cardio-metabolic risk factors including, glycated hemoglobin A1c (HbA1c), fasting plasma glucose (FPG), systolic blood pressure (SBP), diastolic blood pressure (DBP), low-density lipoprotein (LDL) cholesterol, and body mass index (BMI). FPG was quantified using the hexokinase/kinetic method in Chennai and Delhi and the glucose oxidase/end point method in Karachi. HbA1c was quantified using high-performance liquid chromatography at all three sites. LDL cholesterol was estimated using concentrations of total cholesterol, triglycerides, and high-density lipoprotein (HDL) cholesterol by the Friedewald formula.[22] Trained study staff measured weight, height, and blood pressure (BP) using standardized procedures.[20] BMI was calculated as weight (kg) divided by height-squared (m^2). We used these variables as continuous measures in all analyses.

Confounders

We identified potential confounders from the CARRS study questionnaire including study site, age (years), sex, education (primary school, high school to secondary school, or graduate school and above), household income (<10,000 INR/yr, 10,000-20,000 INR/yr, or >20,000 INR/yr; responses from the Karachi site were converted from PKR to INR equivalencies, and then categorized into these three categories), alcohol use (use regularly, past/occasional use, or never used), tobacco use (current user, past user, or never used), moderate physical activity level (≥150 minutes/week, <150 minutes/week, or none), diabetes duration (months), oral diabetic medications (yes or no), physician-diagnosed hyperlipidemia (yes or no), physician-diagnosed hypertension (yes or no), family history of cardio-metabolic diseases (including hypertension, diabetes, heart disease, and stroke), and vegetarianism (defined as those who eat meat, poultry, and fish never or less than once per month).[23]

Statistical analysis

We used SUDAAN (RTI International, Research Triangle Park, NC) software to account for complex survey design in our analysis. We reported results as weighted percentages and unweighted counts unless otherwise specified.

In order to assess the associations between being prescribed a diabetic diet and following a diabetic diet, we estimated prevalence ratios and 95% confidence intervals (CI) using weighted counts. We used Wald chi-square statistics with Satterthwaite correction to test for statistically significant differences between the four groups defined above with respect to socio-demographic characteristics, self-reported diagnosed co-morbidities, and dietary intake. We used one-way analysis of variance (ANOVA) to test whether continuous variables such as age, HbA1c, FPG, SBP, DBP, LDL cholesterol, and BMI were statistically significantly different between groups.

We used multivariable linear regression to estimate associations between the four groups with HbA1c, FPG, SBP, DBP, LDL cholesterol, and BMI. All categorical independent variables, including the exposure (e.g. four groups based on whether they were prescribed dietary modifications and whether they reported following diabetic diets) were specified in the models using indicator variables. Three separate models were run for each outcome variable: (1) an unadjusted model, and models adjusting for (2) socio-demographic variables that were associated with diet group (study site, sex, education, household income, alcohol use, and tobacco use), and (3) the socio-demographic factors from model 2 plus self-reported physician-diagnosed hyperlipidemia and hypertension. Sensitivity analyses were conducted as follows: (1) further adjustment for family history of cardio-metabolic disease, (2) further adjustment for diabetes duration, and (3) further adjustment for moderate physical activity level.

RESULTS

Approximately 24% of participants with self-reported diabetes were prescribed a diet for diabetes and reported following one, 10% reported following a diabetic diet despite not being prescribed one, 12% reported not following a diabetic diet despite being prescribed one, and over half (53%) reported not being prescribed or following a diet (Table 1). When we assessed the association between having been prescribed a diabetic diet and following a diabetic diet, those who reported being prescribed a diet were significantly more likely to report following a diabetic diet than those who were not prescribed a diet: prevalence ratio (95% CI), 4.20 (3.27, 5.34).

Table 1. Percentages (and frequencies) of participants with self-reported diabetes who reported following a diabetic diet or being prescribed a diabetic diet in the CARRS Cohort Study (n=1849)†

	Follow a diabetic diet	Do not follow a diabetic diet
Prescribed a diabetic diet	24.4% (440)	12.1% (221)
Not prescribed a diabetic diet	10.2% (201)	53.4% (987)

†Percentages reported are weighted percentages of the total. Frequencies reported are unweighted counts.

We noted differences in socio-demographic characteristics of those reporting being prescribed and/or following diabetic diets (Table 2). Those who reported being prescribed and following a diet were more likely to have a higher education (p<0.001) and earn an income >20,000 INR/yr (p<0.001). Those who were not prescribed a diet were more likely to use alcohol regularly and those who did not follow a diet were more likely to be current tobacco users (p<0.01). We noted no significant differences in age (p=0.49) or sex (p=0.09) across the four groups. Those who were prescribed a diet were more likely to report physician-diagnosed hyperlipidemia (p=0.01) and those who were neither prescribed nor following a diet were less likely to report physician-diagnosed hypertension (p=0.02). Those who reported following a diet despite not being prescribed a diet were most likely to report ≥150 minutes/week of moderate physical activity and those not prescribed nor following a diet were most likely to report no moderate physical activity (p<0.0001).

There were significant differences in frequency of food group consumption (times/day) between the four groups for all food groups except milk and milk products, nuts and seeds, fruit juice, deep-fried foods, and sugar-sweetened beverages (Figure 1). The most significant differences were in meat and organ meats, poultry, fish and shellfish, legumes and pulses, whole grains, refined grains, and coffee and tea (all p<0.0001). For all meats (meats and organ meats, poultry, and fish and shellfish) the lowest frequency of consumption was in participants who reported both being prescribed and following a diet. For the fish and shellfish category, those not prescribed a diet ate fish or shellfish almost twice as frequently as those prescribed a diet, with the most frequent consumers being those who do not follow a diet and were not prescribed one. In the legumes and pulses category, there was greater frequency of consumption in those who followed a diet compared to those who do not. Frequency of whole grain consumption was higher and refined grain consumption lower in those who were prescribed a diet compared to those who were not prescribed a diet.

The only marker of cardio-metabolic risk that was significantly different between the four groups was LDL cholesterol: those who reported not following a diabetic diet and were not prescribed one had higher LDL cholesterol compared to those who did follow diabetic diets regardless of whether or not they were prescribed one (p=0.01) (Table 2). In unadjusted linear regression

Table 2. Study site and socio-demographic characteristics of CARRS Cohort Study participants with self-reported diabetes according to diabetic diet (n=1849)†

	Follow diet		Do not follow diet		
	Prescribed (n=440)	Not prescribed (n=201)	Prescribed (n=221)	Not prescribed (n=987)	*p* value ‡
Study site					<0.0001
Chennai	18.8% (91)	48.8% (103)	19.4% (49)	63.1% (637)	
New Delhi	70.5% (300)	34.2% (66)	36.4% (74)	17.6% (164)	
Karachi	10.7% (49)	17.1% (32)	44.2% (98)	19.3% (186)	
Characteristics					
Age (years)	52.3 (0.61)	52.8 (0.97)	52.1 (1.11)	51.4 (0.50)	0.49
Sex					0.09
Women	53.3% (242)	49.0% (99)	62.8% (139)	50.9% (497)	
Men	46.7% (198)	51.0% (102)	37.2% (82)	49.1% (490)	
Education					0.0005
Up to primary school	14.7% (78)	20.5% (45)	24.9% (59)	24.3% (254)	
High school to secondary school	57.5% (254)	58.9% (126)	59.8% (127)	62.9% (615)	
Graduate school and above	27.8% (108)	20.6% (30)	15.3% (35)	12.9% (118)	
Income					<0.0001
<10,000 INR/yr	37.8% (168)	44.0% (101)	38.6% (83)	62.0% (615)	
10,000-20,000 INR/yr	20.4% (101)	25.8% (48)	25.5% (59)	21.7% (210)	
>20,000 INR/yr	41.8% (167)	30.3% (50)	35.9% (76)	16.3% (153)	
Alcohol use					0.007
Use regularly	3.2% (11)	5.7% (12)	1.0% (2)	6.5% (63)	
Past or occasional use	8.9% (40)	8.6% (18)	8.2% (16)	10.3% (100)	
Never used alcohol	87.9% (389)	85.7% (171)	90.8% (203)	83.2% (824)	
Tobacco use					0.007
Current user	15.9% (68)	18.7% (34)	24.6% (55)	23.2% (204)	
Past user	1.9% (12)	1.2% (3)	6.5% (13)	3.2% (34)	
Never used	82.2% (360)	80.2% (164)	68.9% (152)	73.7% (749)	
Moderate physical activity					<0.0001
≥150 min/wk	9.9% (47)	16.4% (30)	12.5% (25)	9.6% (80)	
<150 min/wk	17.0% (69)	7.7% (13)	14.4% (36)	6.9% (67)	
None	73.1% (324)	75.9% (158)	73.2% (160)	83.5% (840)	
HbA1c (%)	8.7 (0.13)	8.7 (0.20)	8.6 (0.22)	8.7 (0.11)	0.98
Fasting plasma glucose (mg/dL)	174.5 (4.45)	169.4 (6.85)	168.7 (6.71)	173.2 (3.60)	0.82
Systolic blood pressure (mmHg)	133.9 (1.46)	134.9(1.63)	133.2 (1.91)	132.3 (1.04)	0.59
Diastolic blood pressure (mmHg)	85.5 (0.66)	86.4 (1.19)	84.7 (0.88)	84.8 (0.54)	0.50
LDL cholesterol (mg/dL)	105.6 (1.72)	102.2 (3.04)	111.4 (3.26)	112.4 (1.51)	0.01
Body mass index (kg/m^2)	27.3 (0.37)	27.0 (0.34)	27.9 (0.53)	26.9 (0.26)	0.22
Diabetes duration (months)	84.9 (4.22)	91.4 (6.92)	80.4 (5.41)	75.8 (4.11)	0.13
Prescribed oral diabetic medications					0.15
Yes	89.7% (398)	92.0% (183)	82.5% (184)	89.6% (888)	
No	10.3% (42)	8.0% (18)	17.5% (37)	10.4% (99)	
Self-reported hyperlipidemia					0.01
Yes	13.8% (47)	9.1% (21)	14.1% (31)	7.4% (78)	
No	86.2% (391)	90.9% (180)	85.9% (189)	92.6% (904)	
Self-reported hyperlipidemia treatment§					0.33
Yes	83.5% (39)	91.5% (18)	72.4% (24)	73.3% (63)	
No	16.6% (8)	8.5% (3)	27.6% (7)	26.8% (15)	
Self-reported hypertension					0.02
Yes	42.5% (186)	48.8% (90)	50.4% (118)	37.8% (371)	
No	57.5% (253)	51.2% (111)	49.6% (103)	62.2% (611)	
Family history of cardio-metabolic disease¶					0.78
Yes	54.7% (217)	51.4% (102)	48.7% (98)	52.3% (462)	
No	45.3% (209)	48.6% (95)	51.3% (119)	47.7% (494)	
Vegetarian					<0.0001
Yes	41.8% (187)	25.2% (50)	25.4% (56)	13.5% (126)	
No	58.2% (253)	74.8% (151)	74.6% (165)	86.6% (861)	

†Values presented are weighted mean (weighted SD) or weighted column % (unweighted n).
‡*p* value from one-way analysis of variance (ANOVA) for continuous variables and Satterthwaite-adjusted chi-square tests for categorical variables, comparing socio-demographic and clinical characteristics across the four groups.
§Self-reported treatment with allopathic drugs among those with self-reported physician-diagnosed hyperlipidemia.
¶Self-reported family history of hypertension, diabetes, heart disease, and/or stroke.

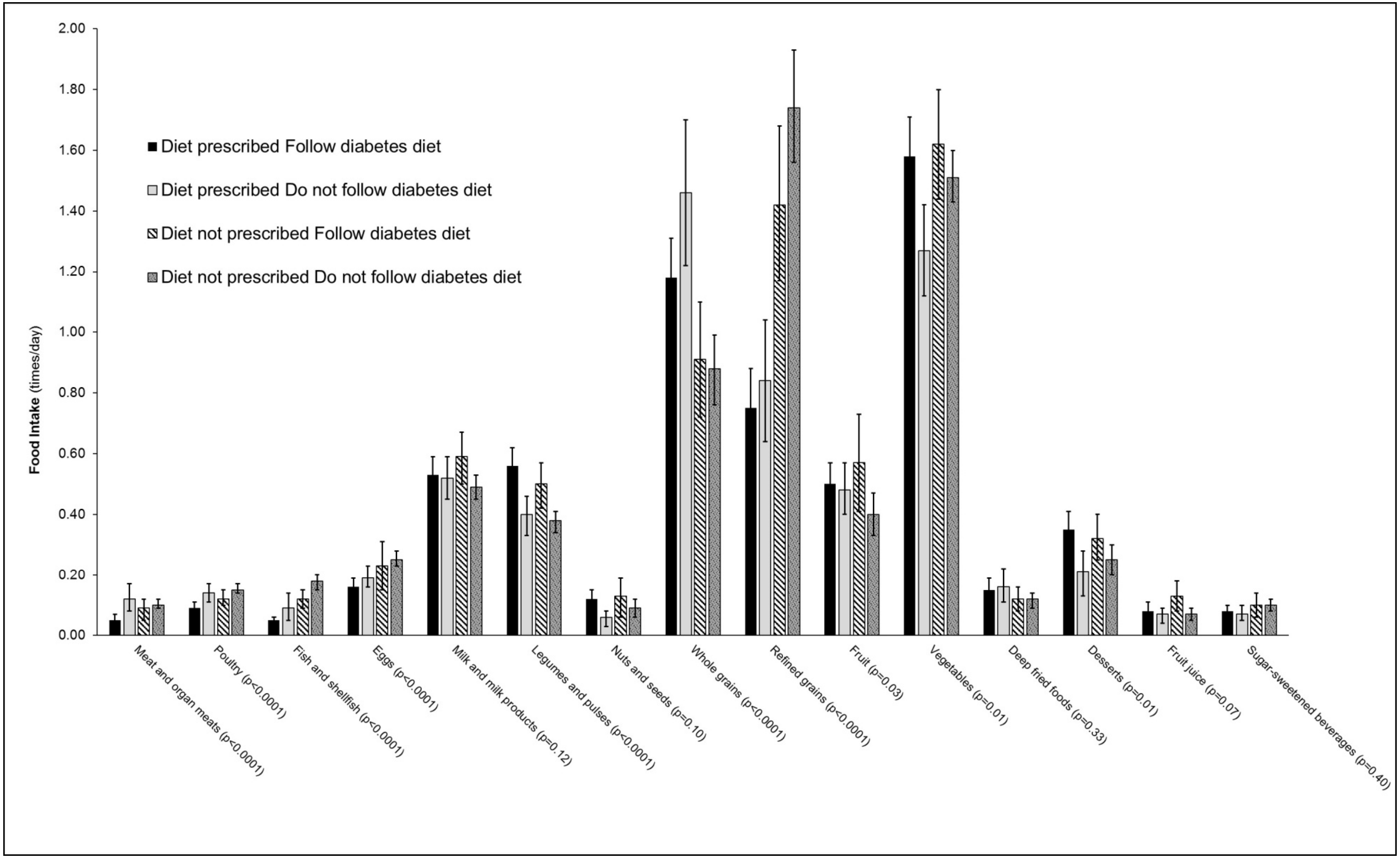

Figure 1. Self-reported food intake (times/day) according to diabetic diet groups among participants with self-reported diabetes in the CARRS Cohort Study. Vertical bars depicting 95% confidence intervals and *p* values corresponding to Satterthwaite-adjusted chi-square tests. Both Western and South Asian desserts were included in the dessert category.

Table 3. Associations of diabetic diet group with HbA1c, fasting plasma glucose, systolic blood pressure, diastolic blood pressure, LDL cholesterol, and body mass index in the CARRS Cohort Study. †

	Model 1 (unadjusted)	Model 2 (adjusted for study site, sex, education, income, alcohol and tobacco use)	Model 3 (adjusted for Model 2 + self-reported hypertension or hyperlipidemia)
HbA1c			
Follow diet + Prescribed diet	-0.00 (-0.33, 0.32)	-0.02 (-0.43, 0.38)	-0.03 (-0.42, 0.35)
Follow diet + Not prescribed diet	-0.03 (-0.44, 0.38)	-0.00 (-0.39, 0.39)	0.01 (-0.38, 0.40)
Do not follow diet + Prescribed diet	-0.08 (-0.49, 0.33)	-0.07 (-0.48, 0.34)	-0.08 (-0.52, 0.35)
Do not follow diet + Not prescribed diet	ref	ref	ref
Fasting plasma glucose			
Follow diet + Prescribed diet	1.40 (-9.57, 12.37)	-7.25 (-22.62, 8.12)	-6.61 (-21.25, 8.02)
Follow diet + Not prescribed diet	-3.75 (-17.15, 9.65)	-6.19 (-20.45, 8.06)	-5.72 (-20.42, 8.98)
Do not follow diet + Prescribed diet	-4.40 (-17.15, 8.34)	-7.82 (-22.02, 6.39)	-6.28 (-20.55, 7.99)
Do not follow diet + Not prescribed diet	ref	ref	ref
Systolic blood pressure			
Follow diet + Prescribed diet	1.63 (-1.80, 5.06)	-0.25 (-4.06, 3.57)	0.31 (-3.34, 3.95)
Follow diet + Not prescribed diet	2.56 (-0.90, 6.01)	1.88 (-1.67, 5.44)	1.10 (-2.17, 4.38)
Do not follow diet + Prescribed diet	0.93 (-3.72, 5.57)	-0.86 (-5.49, 3.77)	-0.37 (-4.65, 3.91)
Do not follow diet + Not prescribed diet	ref	ref	ref
Diastolic blood pressure			
Follow diet + Prescribed diet	0.70 (-1.05, 2.45)	-0.21 (-2.12, 1.70)	0.03 (-1.91, 1.96)
Follow diet + Not prescribed diet	1.67 (-0.82, 4.15)	1.25 (-1.46, 3.96)	0.90 (-1.73, 3.53)
Do not follow diet + Prescribed diet	-0.10 (-2.32, 2.12)	-0.24 (-2.50, 2.02)	0.00 (-2.08, 2.09)
Do not follow diet + Not prescribed diet	ref	ref	ref
LDL cholesterol			
Follow diet + Prescribed diet	-6.72 (-11.38, -2.06)	-5.92 (-11.64, -0.19)	-5.22 (-11.12, 0.67)
Follow diet + Not prescribed diet	-10.14 (-16.89, -3.39)	-9.36 (-16.42, -2.29)	-8.54 (-15.50, -1.58)
Do not follow diet + Prescribed diet	-0.96 (-8.13, 6.21)	-1.33 (-8.98, 6.33)	-0.10 (-7.62, 7.42)
Do not follow diet + Not prescribed diet	ref	ref	ref
Body mass index			
Follow diet + Prescribed diet	0.39 (-0.53, 1.31)	-0.36 (-1.32, 0.61)	-0.36 (-1.32, 0.60)
Follow diet + Not prescribed diet	0.17 (-0.64, 0.98)	-0.17 (-1.03, 0.68)	-0.30 (-1.19, 0.58)
Do not follow diet + Prescribed diet	1.07 (-0.03, 2.18)	0.47 (-0.61, 1.55)	0.48 (-0.62, 1.58)
Do not follow diet + Not prescribed diet	ref	ref	ref

†Values presented are Beta (95% confidence interval).

models (Table 3), both the prescribed/following and the not prescribed/following diet groups had lower LDL cholesterol compared to the not following/not prescribed diet group, with mean differences of -6.72 mg/dL (95% CI: -11.28, -2.06) and -10.15 mg/dL (95% CI: -16.89, -3.39), respectively. However, after adjustment for socio-demographic variables, tobacco and alcohol use, and self-reported physician-diagnosed hypertension and hyperlipidemia, only the not prescribed/following diet group had significantly lower LDL cholesterol compared to the not prescribed/not following diet group: mean difference of -8.54 mg/dL (95% CI: -15.5, -1.58). Further adjustment for family history of cardio-metabolic disease, diabetes duration, and moderate physical activity level in sensitivity analyses did not substantially affect results (Supplemental Online Material).

DISCUSSION

In this large, three-city study in South Asia, though participants who were prescribed diabetic diets were more likely to follow them, the majority of participants was neither prescribed nor followed such diets. Whole grains were consumed more frequently and refined grains less frequently among those who were prescribed a diabetic diet compared to those who were not prescribed a diabetic diet. Reported following of a diabetic diet was associated with lower LDL cholesterol; however, the effect was attenuated after accounting for physician-diagnosed hypertension and hyperlipidemia, suggesting that the lower LDL cholesterol observed in these participants may be attributable to factors other than following a diabetic diet, such as statin use or increased access to care. Importantly, no other significant associations with clinical outcomes were observed, thus, dietary modifications may not be big enough or consistent enough to produce any meaningful change in health outcomes including glycemic control in this population.

Approximately one-third of participants with self-reported diabetes in this representative urban South Asian cohort reported following diabetic diets. This is consistent with other studies of individuals with diabetes conducted in Karachi, Pakistan,[10,11] the southern India state of Tamil Nadu,[7] and the western India city of Ahmedabad,[9] which found self-reported adherence to diabetic diets ranged from 29% to 77%. Given that healthier diets have been shown to have significant benefits in terms of lowering disability, depression, the need for blood pressure and lipid medications, and preserving quality of life among individuals with diabetes,[6] increasing the proportion of individuals with diabetes following diabetic diets in South Asia should be a priority moving forward.

We found that individuals with diabetes who were prescribed diabetic diets were over four times more likely to follow diabetic diets than those who were not prescribed them. However, only 36.5% of participants with self-reported diabetes were prescribed dietary modifications by their physicians in our cohort. In contrast, the STARCH study found that over half (56.6%) of all individuals with type 2 diabetes were recommended a diet by their physician.[12] While the STARCH study was conducted at specialized endocrinology centers, the CARRS cohort was a representative, population-based study; as such, adherence to current standards of care by health care providers may vary considerably.

Although access, income, and social pressures complicate adherence to diabetic diets, physician recommendation of diabetic diets should be more straightforward. The Look AHEAD Trial demonstrated that an intensive lifestyle intervention that included dietary modification in obese individuals with diabetes led to significant long-term improvements in glycemic control and quality of life, and reduced healthcare costs.[6] In post hoc analyses of the PREDIMED Trial, a Mediterranean diet supplemented with extra-virgin olive oil was found to be significantly protective against cardiovascular disease and diabetic retinopathy relative to a control diet among participants with diabetes.[24,25] A review article highlighted that lifestyle interventions in low- and middle-income countries including China and Thailand have also demonstrated reductions of HbA1c in individuals with diabetes, though not necessarily of the same magnitude as observed in high-income countries.[5]

Despite the incomplete adherence seen in our study, participants who were prescribed dietary modifications by their physicians were still over four times more likely to report following a diet than those who were not. Thus, simply increasing the frequency that physicians recommend dietary changes to individuals with diabetes may be an important initial step to increase adoption of healthier dietary choices. Indeed, a 9-year prospective study of individuals with diabetes at a tertiary care center in Chennai, India, recently showed that people who have more regular follow up do much better than those with irregular follow up in terms of glycemic control, blood lipids, and nephropathy.[26] Similarly, a small (n=175) study comparing patient outcomes between a comprehensive diabetes care center and two limited care centers in Kerala, India, found significantly lower HbA1c, cholesterol, and DBP among patients at the comprehensive diabetes center.[27] The authors attributed the difference to more aggressive treatment regimens and real-time, frequent communication with health professionals via a telemedicine program.[27] In settings where access to physicians is limited, multidisciplinary care teams that involve either case managers, nurses, or other providers who can adjust prescriptions and counsel patients independently of physicians have also been shown to improve glycemic control.[28] Moreover, dietary prescription appears to be safe. The US Preventive Services Task Force recently updated its recommendations for intensive dietary counseling among overweight or obese individuals with cardiovascular disease risk factors – a process that included a thorough evaluation of potential harms of such counseling – and found that none of the dietary intervention studies reported any adverse events.[29] They also found "no consistent evidence that behavioral counseling interventions led to paradoxical changes in intermediate or behavioral outcomes."[29]

In our cohort, those who were prescribed a diet were more likely to have higher income levels. This difference could either be due to providers treating individuals with diabetes differently by income/education or individuals with diabetes of different income/education levels seeing different providers. It may also be affected by limited access to care for low-income individuals. However, those with a higher income were not necessarily more likely to follow the diets. This is consistent with several studies in India that demonstrated that despite high socio-economic status, knowledge of healthy food choices and nutrition is generally poor.[13,15,16] Poor understanding of nutrition and its importance among individuals with diabetes is a substantial barrier to changing dietary behavior in this high-risk group.[14]

The four groups described in our study were associated with significant differences in dietary intake, particularly with respect to refined grains, whole grains, vegetables, and animal-based products (meat, poultry, and fish/shellfish). Those who were prescribed a diet had lower frequencies of refined grain intake and higher frequencies of whole grain intake. This may reflect adherence to the tenets of diabetic diets as the guidelines generally suggest limiting simple carbohydrates in exchange for more complex, high-fiber carbohydrates.[30-32] It is interesting to note that among individuals *not* prescribed a diabetic diet but who reported following a diabetic diet, intake of refined grains was nearly as high as that among those not prescribed a diet and reportedly not following a diet. This observation further supports the conclusion that nutrition knowledge among patients with diabetes is poor. For the different animal-based products, those who reported following diabetic diets as well as those who were prescribed them ate meat, poultry, eggs, and fish/shellfish less frequently than those who were not prescribed/following a diet. Vegetables were eaten more often by those who reported following a diet than those not following a diet. However, desserts were also eaten more often by those who reported following a diet than those not following a diet. These dietary modifications are in contrast to the STARCH study, which found that carbohydrate intake was not significantly different between those who did and did not report adhering to diabetic diets.[12] Unfortunately, because the CARRS food propensity questionnaire did not include estimates of portion size, we were unable to calculate the macronutrient composition of the diet.

The only cardio-metabolic outcome consistently associated with the four diet groups was LDL cholesterol, which was lower in participants who adhered to diabetic diets. This is a beneficial finding given that LDL cholesterol is an important risk factor for cardiovascular disease.[33] We did not see any statistically significant associations between diet group and other clinical outcomes. This may indicate that the diabetic diets followed by CARRS participants with self-reported diabetes are not associated with improved glycemic control or decreased cardio-metabolic risk, or it may be that the dietary modifications we observed were not big enough or consistent enough to produce any meaningful change in health outcomes. The adoption of more culturally appropriate dietary guidelines that emphasize the healthful aspects of traditional South Asian diets may result in improved adherence, and subsequently more significant improvements in health outcomes.[17] These recommendations could include, for example, for carbohydrates, increasing intake of millets (pearl millet [*bajra*], finger millet [*ragi*], etc.), unpolished or parboiled rice, pulses (*dal*, *chana*, etc.), and whole fruits; and for fats, restricting partially hydrogenated vegetables oils (*vanaspati*) and increasing intake of nuts (cashews, etc.) and low-fat (e.g. double-toned) milk products.[17]

A key limitation of this and previous studies is that being prescribed a diabetic diet and following a diabetic diet were specified as binary variables. Merely asking individuals with diabetes whether they have been prescribed dietary modifications does not capture the degree of education and counseling provided: those simply told what to eat and what to avoid and those given daily meal plans with detailed instructions would both respond, “yes”, but likely have very different outcomes. This homogeneity within our exposure group may partially explain the null associations we saw with many of the clinical outcomes. It would be informative to have a more sensitive measurement that takes into consideration how and how frequently individuals were counseled and to what extent they followed recommendations. Another limitation of this study is that dietary intake was assessed using a 26-item questionnaire that did not specifically query type of fat consumed and so we were unable to evaluate the association of fat intake with the health outcomes. Moreover, the diet questionnaire did not assess specific types of grains, e.g. rice versus wheat versus other grains. Future studies should use more detailed diet assessment instruments to answer questions relating to these foods.

Overall, the results of our study indicate that diets are not followed or recommended frequently for individuals with diabetes in South Asia. There are clearly multiple barriers to changing dietary behavior in this high-risk group including: poor understanding of nutrition and its importance for health;[13-16] low rates of physicians recommending dietary modifications;[12] limited access to diabetes education and counseling;[9] limited access to dietary alternatives;[18,19] cultural/religious practices;[17] and lack of motivation to change.[7,12,16] Despite these, our data suggest that enabling individuals with diabetes to make dietary modifications may lead to an increased likelihood of following diabetic diets and healthier dietary choices. Given the known benefits of lifestyle changes for the management of diabetes,[3-5] increasing the quality and frequency of diabetes education and counseling, particularly regarding diet, should be a priority in South Asia as the burden of diabetes continues to grow.

AUTHOR DISCLOSURES

The authors have no conflicts of interest to declare.

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