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Education and psychological issues Diabetes nutrition therapy and dietary intake among individuals with Type 1 diabetes in China

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Abstract

Aims—To describe the contribution of diabetes nutrition therapy to disease self-management among individuals with Type 1 diabetes mellitus in China and to estimate the association of diabetes nutrition therapy with dietary intake.

Methods—The 3C Study was an epidemiological study of the coverage, cost and care of Type 1 diabetes in China. The data reported in the present study are from the 3C Nutrition Ancillary Study, a follow-up study conducted 1.6±0.2 years later. Diabetes nutrition therapy was assessed by an interviewer-administered questionnaire. Dietary intake was assessed using three 24-h recalls. The association of diabetes nutrition therapy with dietary intake was estimated using ANCOVA.

Results—Participants ($n=100$; 54% male) had a mean $\pm$ SD age of 41.7±16.3 years old and a mean $\pm$ SD diabetes duration of 11.8±9.7 years. Fewer than half of the participants reported that they had 'ever' met with a dietician. While 64% of participants were taught carbohydrate counting, only 12% 'ever' use this tool. Participants on insulin pumps and those testing 1 time/day reported greater dietary flexibility and higher fruit intakes compared with participants on other insulin regimens and testing less frequently. After adjustment for confounding by age and occupation, there were no consistent differences in dietary intake across subgroups of diabetes nutrition therapy.

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Competing interests None declared.

Supporting information Additional Supporting Information may be found in the online version of this article:

Appendix S1 Relative validity of telephone administered 24-h dietary recalls compared with face-to-face administered 24-h dietary recalls.

Data from this study were presented as a poster at the 74th Scientific Sessions of the American Diabetes Association, San Francisco, California, 14 June 2014.

Conclusions—In this sample of individuals with Type 1 diabetes in China there is little dietician involvement or carbohydrate counting. Increased frequency of nutrition education in conjunction with intensified self-monitoring of blood glucose is needed to improve care.

Introduction

The coordination of insulin with dietary intake is essential among people with Type 1 diabetes mellitus so as to maintain near-normal blood glucose levels and prevent acute and chronic complications [1]. This integration is achieved through individualized diabetes nutrition therapy, which typically involves one of two approaches: (1) fixed daily insulin doses matched to consistent carbohydrate intake with respect to time and amount or (2) flexible daily insulin doses accommodating variability in food intake, typically using carbohydrate counting [2]. There is not a ‘one-size-fits-all’ eating pattern for diabetes [2]. Healthcare providers—preferably dietitians or their equivalent—should collaboratively develop eating plans with each individual with diabetes and provide ongoing implementation support [2].

Currently, data on Type 1 diabetes care outside of the USA and Europe are scarce. While China has the largest number of people with Type 1 diabetes in the Western Pacific Region and evidence suggests the incidence is increasing [3–5], most of our knowledge on Type 1 diabetes care in China is severely outdated. Information regarding incidence in this region is typically drawn from the WHO’s Multinational Project for Childhood Diabetes (the WHO DIAMOND Project) [6–11], conducted between 1990 and 1999, and information on self-management and glycaemic control from a cross-sectional study conducted by the International Diabetes Federation between 2001 and 2002 [12]. The latter found that children and adolescents with Type 1 diabetes in China had the lowest mean daily insulin dose and the lowest frequency of self-monitoring of blood glucose (SMBG) among Western Pacific countries [12]. This may explain the high HbA_{1c} level for the sample, a mean of 80.3 mmol/mol (9.5%) [12].

Several barriers to improving Type 1 diabetes care in China persist despite dramatic improvements in the developed world. Cost remains a substantial problem; although insulin is covered in part by most health insurance policies, insulin injection tools, blood glucose testing strips and blood glucose meters are expensive and not covered by insurance. On average, one-third of an urban family’s income is spent on care for a patient with Type 1 diabetes in China [13]. The lack of diabetes educators [14] and the common requirement for inpatient admission to receive diabetes education [15] are also major barriers. Additional barriers include misconceptions relating to Chinese traditional medicine, time limitations of healthcare providers, and discrimination against individuals with Type 1 diabetes.

To date, no study has evaluated diabetes nutrition therapy among individuals with Type 1 diabetes in China. Understanding current practices is an essential first step for developing interventions and policies to improve Type 1 diabetes care. The aims of the present study were: (1) to describe the contribution of diabetes nutrition therapy to disease self-management among individuals with Type 1 diabetes in China and (2) to estimate the association of diabetes nutrition therapy with dietary intake.

Methods

Sample population

The 3C Study was an epidemiological study of the coverage and cost of Type 1 diabetes care in China [16]. Dietary intake in the 3C Study was assessed using the Summary of Diabetes Self-Care Activities measure, which includes four questions relating to general dietary intake [17]. The present follow-up study, the 3C Nutrition Ancillary Study (3CNAS), was conducted 1.6±0.2 years later and expanded the 3C Study to include detailed information on diabetes nutrition therapy and dietary intake. 3C Study participants who met the following criteria were eligible for the 3CNAS: residence in Beijing; age ≥12 years; absence of severe diabetes complications (e.g. advanced micro- and macrovascular complications, including nephropathy and stroke); and an available in-service telephone number.

All procedures were approved by the University of North Carolina Office of Human Research Ethics and the Peking University Biomedical Institutional Review Board, and all participants provided written informed consent (≥18 years of age) or written parent permission and participant assent (12 to <18 years of age).

Diabetes nutrition therapy assessment

Trained interviewers administered a survey during the 3CNAS visit that queried recommendations received from healthcare providers relating to general diabetes care and nutrition. Specifically, participants were asked how often, if ever, they had met with a dietician; if they had received an eating plan and if yes, how often they followed it, and if they had ever been taught carbohydrate counting and if yes, who taught them and how often they used it. An open-ended question was also asked relating to what the participant would like to know about how food interacts with their diabetes care.

Information on insulin administration method, type and dose, and SMBG were also collected during the 3CNAS visit. Four insulin regimens were defined as follows: (1) multiple daily injections (≥3 injections) with glargine or detemir plus more than/or other than rapid-acting insulin (multiple daily injections with basal insulin regimen); (2) continuous subcutaneous infusion (pump regimen); (3) multiple daily injections with any insulin type excluding glargine and detemir (multiple daily injections and no basal insulin regimen); and (4) 1–2 injections per day of any insulin type (1–2-injection regimen).

Dietary intake assessment

At the end of the 3CNAS visit, participants were trained by dietitians to record their dietary intake on food records provided in an introductory packet. Emphasis was placed on estimating portion sizes using food samples, an electronic scale and a culturally appropriate portion size picture guide. On average, beginning a mean±SD of 3.0±2.8 days after this visit, participants completed three telephone-administered 24-h recalls, which were validated against in-person-administered recalls in a subset of participants ($n=13$; Appendix S1).

The 24-h recalls were administered using a two-step approach: (1) collect a detailed food list and (2) review and confirm the detailed food list. During the first step, an outline of the previous day's intake was collected, with guidance from the completed food record. Interviewers probed for meal type, preparation setting, preparation method and detailed information on any additions to the food, food type, brand names and portion size. During the second step, the detailed food list was re-read and missing foods, beverages and eating occasions were probed. The 24-h recall food lists were converted into nutrients and food groups using the Chinese Food Composition Tables [18,19].

Covariates

Demographic and socio-economic data were collected via an interviewer-administered survey during the 3C Study visit. Diabetes duration was calculated as the period from 1 July of the year of diagnosis (because the 3C Study only queried year of diagnosis) to the 3CNAS visit.

A blood sample was collected by venipuncture during the 3CNAS visit and HbA_{1c} level was measured using standardized procedures in whole blood with an automated high-performance liquid chromatography system (Primus Ultra², Trinity Biotech, Bray, Co Wicklow, Ireland).

Statistical analysis

Univariate descriptive statistics were used to summarize diabetes nutrition therapy and dietary intake. Differences in diabetes nutrition therapy across disease self-management subgroups were evaluated using chi-squared tests for categorical variables and Kruskal–Wallis tests for continuous variables. The association between diabetes nutrition therapy and dietary intake was estimated using *ANCOVA*. Potential confounders, including age, diabetes duration, sex, household highest level of education, household income, occupation, marital status, medical insurance coverage and urban vs rural residence were evaluated by examining their independent associations with the exposures and outcomes and using directed acyclic graphs [20]. The final adjustment set included age and occupation. All statistical analyses were conducted using *SAS* 9.2 (SAS Institute, Cary, NC, USA).

Results

A total of 195 3C Study participants met the inclusion criteria for the 3CNAS. Of these, 72 (37%) refused to participate and 23 (12%) dropped out before the 3CNAS visit. The final sample size was therefore 100. There were no differences in diabetes duration, sex, household highest level of education or urban vs rural residence between those who participated and those who refused or dropped out (all $P>0.05$); however, those who participated tended to be older ($P=0.001$), have higher household incomes ($P=0.05$), and be retired/unemployed/never worked ($P=0.06$) and married/cohabitating ($P=0.02$).

The mean $\pm$ SD age of the participants was 41.7 ± 16.3 years, the mean $\pm$ SD diabetes duration was 11.8 ± 9.7 years and the mean $\pm$ SD HbA_{1c} was 66 ± 19 mmol/mol ($8.22\pm1.77\%$; Table 1). Approximately one-third of participants were on insulin regimens classified as 'multiple daily injections and no basal insulin'; the most common insulin combination in this category

was three injections/day of short-acting insulin (regular) and one injection/day of intermediate-acting insulin (neutral protamine Hagedorn). SMBG frequency was low: only 8% of participants reported testing 3 times/day.

Fewer than half of participants reported 'ever' meeting with a dietitian (Table 2) and only one participant reported having met with a dietitian in the preceding 12 months. While a greater proportion of participants reported attending an education session in the preceding 12 months that covered nutrition, the number was still low at only 18%.

With regard to diabetes nutrition therapy strategies, 64% of participants reported that they had been taught carbohydrate counting (Table 2) and the majority of these had been taught by a physician (56%). The remaining participants were taught by dietitians (30%), diabetes educators (5%) or other sources, including printed educational materials (3%), the Internet (2%) and nurses (3%). The vast majority (81%) of participants taught carbohydrate counting reported 'never' using this self-management tool. Only two participants who had been taught carbohydrate counting reported practising carbohydrate counting every day. Participants who had been taught carbohydrate counting by dietitians were nearly twice as likely to report sometimes using it (26%) compared with participants who had been taught by physicians (14%), but the difference was not significant ($P=0.51$).

While a slightly greater proportion of participants (72%) had been given an eating plan by a healthcare provider (Table 2) than had been taught carbohydrate counting (64%), participants had only followed their prescribed eating plans for a mean $\pm$ SD of 2.6 ± 3.2 days in the preceding week. Notably, 11% of participants had never been taught carbohydrate counting and had never been given an eating plan by a healthcare provider.

Dietary flexibility in this sample was low: 67% of participants reported eating about the same amount of food at the same time everyday (Table 2). When participants were asked to describe what they did when they ate more or less food than usual, 20% reported that they did nothing because they had a rigid diet. In response to a query about what they would like to know about how food interacts with their diabetes care, 14% of participants responded that they wanted to know how they could eat fruit and 4% explicitly asked if a rigid diet was necessary for patients with Type 1 diabetes and how they could increase the diversity of their diets.

Participants on pumps had the highest dietary flexibility: over half of participants in this group reported eating different amounts or at different times every day and 0% reported doing nothing if their diet varied (Table 2). Participants on 1–2 injections/day were least likely to adjust their insulin in response to eating more or less than usual. Participants on pumps had higher fruit ($P=0.07$) and dairy ($P=0.04$) intakes relative to other participants (data not shown).

Participants who tested 1 time/day were more likely to report adjusting insulin in response to dietary variability and less likely to report doing nothing because they had a rigid diet ($P=0.05$). They also had significantly ($P=0.005$) higher fruit intakes compared with participants testing with lower frequencies (data not shown).

A greater proportion of participants who had attended an education session that covered nutrition in the preceding 12 months achieved HbA_{1c} goals (29%) compared with participants who had not attended such a session (15%), but the difference was not significant in this sample ($P=0.11$). Similarly, while a greater proportion of participants who had ever met with a dietician met HbA_{1c} goals (58%) compared with those who had never met with a dietician (44%), the difference was not significant ($P=0.22$).

There were few differences in dietary intake across subgroups of diabetes nutrition therapy (Table 3). Participants who had ever met with a dietician had higher mean iron ($P=0.007$) and egg ($P=0.03$) intakes than did participants who had never met with a dietician. Participants who had attended an education in the preceding 12 months that covered nutrition had higher mean vegetable intakes ($P=0.02$) than those who had not. Finally, participants who had been given an eating plan but never used it had a lower mean percent of calories from fat ($P=0.01$) and a higher mean percent of calories from carbohydrate ($P=0.05$) compared with those who had been given an eating plan and used it and those who had never been given an eating plan.

Discussion

The present study is the first to assess the integration of diabetes nutrition therapy, self-management practices and dietary intake among patients with Type 1 diabetes in a developing country. Fewer than half of participants had ‘ever’ met with a dietician and the frequency of diabetes nutrition therapy approaches such as carbohydrate counting was low. Results indicate that diabetes nutrition therapy in China typically involves matching fixed insulin doses to a diet that is rigid with respect to amount and timing. While the consistency of this self-management regimen may be appropriate for some participants, others expressed a desire to diversify their diets, particularly with respect to fruit intake.

The American Diabetes Association recommends meeting with a dietician annually or attending a diabetes self-management education programme that includes instruction on nutrition therapy [2,21]. Only one out of the 100 participants in this sample—an older male participant with poor glycaemic control and with possible microalbuminuria—had met with a dietician in the preceding 12 months, suggesting that dieticians are only used in high-risk situations in China. A larger proportion of participants had attended an education session that covered nutrition in the preceding 12 months, but the proportion was still dismally low at only 18%. This may explain why only 12% of participants sometimes use carbohydrate counting and only 32% sometimes follow an eating plan given to them by their healthcare provider. This is in stark contrast to young people with Type 1 diabetes in the USA, 97% of whom have been taught carbohydrate counting and 86% of whom report using this approach ‘often’ [22].

Although participants on a multiple daily injection with basal insulin regimen or a pump regimen had significantly higher SMBG frequencies compared with participants on other insulin regimens, only about half of them tested 1 time/day. The American Diabetes Association recommends SMBG before all meals and snacks, occasionally postprandially, and at bedtime, in addition to other situations (e.g. when hypoglycaemia is suspected) for a

total of 6–8 times/day [23]. The reportedly low frequency of SMBG in the present sample population, which is consistent with the most recently published data in China (from 2001 to 2002; average SMBG of eight times/month) [12], may help explain why diabetes nutrition therapy frequency is so low and why such a large proportion of participants on multiple daily injections reported having rigid dietary intakes. This low SMBG frequency poses a significant barrier for physicians in China who cannot advise patients appropriately with respect to diet because of a lack of information on SMBG (most patients do not bring SMBG results to their outpatient visits). For example, a patient may ask a physician in the outpatient department how he/she can eat fruit, but without data on SMBG the physician's ability to advise the patient is severely limited.

In the present sample, vegetable and fruit intakes were below the Chinese Food Guide Pagoda recommendations: a mean of 389 g/day of vegetables compared with the recommended 400–500 g/day and a mean of 78 g/day of fruit compared with the recommended 100–200 g/day [24]. This may have contributed to the observed fibre intakes, which were half those recommended by the US Institute of Medicine [25]. Interestingly, 14% of participants responded that they wanted to know how they could eat fruit, which indicates that individuals with Type 1 diabetes in China are purposely restricting fruit intake. This phenomenon has also been reported in the USA: in a small focus group study of young people, although all participants perceived fruit as healthy, a few parents reported limiting or even excluding fruit consumption because of risk of postprandial hyperglycaemia [26]. In the present study, participants on a pump regimen and those who tested more frequently had higher fruit intakes relative to other participants, suggesting that these may be viable self-management options for participants wishing to increase their fruit intakes.

A greater proportion of participants who had attended an education session that covered nutrition in the preceding 12 months or who had ever met with a dietician achieved HbA_{1c} goals compared with participants who had not received nutrition education, but the difference was not statistically significant, perhaps because very few participants had attended such an education session or met with a dietician in the preceding 12 months. It may be the case that more frequent nutrition education and contact with dieticians are needed in China to achieve more significant improvements in glycaemic control.

We did not find a clear association between diabetes nutrition therapy and dietary intake in the present sample of individuals with Type 1 diabetes in China. Evidence from both structured [27,28] and psychosocial [29] education interventions suggests that nutrition education can lead to improvements in dietary intake and guideline adherence among individuals with Type 1 diabetes. Furthermore, studies in Europe [30–32] have reported adoption of healthier diets with the receipt of nutrition recommendations as part of routine care, where routine care varied from a single, 5-day inpatient education programme in France [30] to meeting with a dietician during routine outpatient medical consultations every 3 months [31] or twice per year in Italy [32]. There are several potential reasons why no consistent association was observed between diabetes nutrition therapy and dietary intake in the present sample of individuals with Type 1 diabetes in China. Perhaps chief among them is that nutrition education was infrequent and as a result, implementation support may be insufficient to empower patients to make modifications to their diet. Indeed, 74% of

participants in the present study wanted to know more about how food interacts with their diabetes care. Patients in China often express discontent with the education they are currently receiving, complaining that they have not been given the tools they need to understand their body's glycaemic response to food and how to respond appropriately. To address this gap in knowledge, trained clinical dietitians are urgently needed in China and should be integrated into routine patient care. This would require a shift in the role of dietitians to support patient counselling in addition to their traditional role of advising hospital kitchens.

There are several strengths and challenges associated with the present study. An important limitation is the use of self-reported diabetes nutrition therapy: participants may have modified their responses according to what they perceived to be socially desirable, which may have resulted in misclassification. The potential for this bias was addressed by using interviewers who were not the participants' healthcare providers and training them to use a standardized protocol and neutral probes [33]. Compared with ineligible participants and those who declined to participate, individuals who completed the present study were older, and as a result were more likely to be married and not to be working. To improve participant enrolment and generalizability, study visits were conducted both in urban Beijing and in a rural Beijing suburb. Nonetheless, we recognize that, as with all observational studies, the generalizability of the results presented here may be limited. Finally, the sample size of the study was small and therefore limited our power to detect significant differences. Nonetheless, the thoroughness and quality of the data are valuable for improving our grasp of the situation in China and informing future, larger studies.

In the present sample of individuals with Type 1 diabetes in China there was little dietitian involvement in continuing diabetes education and very few participants practised carbohydrate counting. While most participants had been given an eating plan by their healthcare provider, few reported using this plan regularly. To improve health outcomes for individuals with Type 1 diabetes in China, greater access to nutrition education led by dietitians or their equivalent, and diabetes nutrition therapy, as appropriate for patient preferences and insulin regimen, are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What's new?

- This is the first study to assess the integration of nutrition education and diabetes nutrition therapy with disease self-management and dietary intake among individuals with Type 1 diabetes in a developing country.
- Dieticians are largely absent from continuing diabetes education for individuals with Type 1 diabetes in China, and few patients regularly practise self-monitoring of blood glucose or carbohydrate counting.
- To improve health outcomes for patients with Type 1 diabetes in China, greater access to nutrition education led by trained dieticians in conjunction with intensified self-monitoring of blood glucose is urgently needed.

Table 1
Sociodemographic and clinical characteristics of participants with Type 1 diabetes in China

	All N = 100	Male participants N= 54	Female participants N= 46
Mean (SD) age, years	41.7 (16.3)	41.1 (16.7)	42.4 (15.8)
Mean (SD) diabetes duration, years	11.8 (9.7)	9.8 (7.4)	14.2 (11.4) [†]
Household highest level of education, n (%)			
< University	32 (32)	13 (25)	19 (41)
Junior University	16 (16)	8 (15)	8 (17)
University	51 (52)	32 (60)	19 (41)
Household income, n (%)			
< 3000 RMB/month	20 (20)	10 (19)	10 (22)
3000–5000 RMB/month	23 (23)	12 (22)	11 (24)
5000–10 000 RMB/month	30 (30)	16 (30)	14 (30)
10 000 RMB/month	27 (27)	16 (30)	11 (24)
Occupation, n (%)			
Non-government worker	31 (31)	20 (37)	11 (24)
Government worker	17 (17)	8 (15)	9 (20)
Student	17 (17)	12 (22)	5 (11)
Farmer	7 (7)	4 (7)	3 (7)
Retired/unemployed/never worked	28 (28)	10 (19)	18 (39)
Marital status, n (%)			
Married/cohabitating	58 (60)	31 (61)	27 (60)
Single/never married/widowed	38 (40)	20 (39)	18 (40)
Medical insurance, n (%)			
Urban employee	47 (47)	26 (48)	21 (46)
Urban resident	26 (26)	12 (22)	14 (30)
New cooperative	15 (15)	8 (15)	7 (15)
Other	7 (7)	4 (7)	3 (7)
None	5 (5)	4 (7)	1 (2)
Residency status, n (%)			

	All N = 100	Male participants N = 54	Female participants N = 46
Urban	82 (85)	44 (85)	38 (84)
Rural	15 (15)	8 (15)	7 (16)
Achieved HbA _{1c} goal [*] , n (%)			
Yes	24 (24)	13 (24)	11 (24)
No	75 (76)	41 (76)	34 (76)

* HbA_{1c} goal of < 53 mmol/mol (7.0%) for participants > 19 years old and < 58 mmol/mol (7.5%) for participants ≤ 19 years old. From the American Diabetes Association's 2014 Standards of Care and the International Society for Pediatric and Adolescent Diabetes/International Diabetes Federation's 2011 Guidelines for Diabetes in Childhood and Adolescence.

Table 2

Diabetes nutrition therapy according to insulin regimen among individuals with Type 1 diabetes in China^{a,b}

	Insulin regimen				<i>P</i> *
	All <i>N</i> = 100	Multiple daily injections with basal insulin <i>N</i> = 42	Pump <i>N</i> = 9	Multiple daily injections and no basal insulin <i>N</i> = 30	
SMBG, <i>n</i> (%)					
< 1 time/week or not at all	31 (31)	6 (14)	1 (11)	17 (57)	0.005
1–2 times/week	27 (27)	10 (24)	2 (22)	8 (27)	
3–6 times/week	12 (12)	7 (17)	2 (22)	2 (7)	
1 time/day	30 (30)	19 (45)	4 (44)	3 (10)	
Dietary flexibility, <i>n</i> (%)					
Eat same amount at same time everyday	67 (67)	32 (76)	4 (44)	17 (57)	0.14
Eat different amounts or at different times everyday	33 (33)	10 (24)	5 (56)	13 (43)	
Action if diet varies, <i>n</i> (%)					
Adjustment of insulin	57 (57)	26 (62)	6 (67)	17 (57)	0.21
Adjustment of insulin or exercise	8 (8)	5 (12)	2 (22)	0 (0)	
Adjustment of exercise	15 (15)	5 (12)	1 (11)	5 (17)	
None: rigid diet	20 (20)	6 (14)	0 (0)	8 (27)	
Ever met with a dietician, <i>n</i> (%)					
Yes	48 (48)	22 (52)	4 (44)	15 (50)	0.71
No	52 (52)	20 (48)	5 (56)	15 (50)	
Individual or group education in preceding 12 months that covered nutrition, <i>n</i> (%)					
Yes	18 (18)	10 (24)	0 (0)	5 (17)	0.39
No	82 (82)	32 (76)	9 (100)	25 (83)	

Insulin regimen				
	All N = 100	Multiple daily injections with basal insulin N = 42	Pump N = 9	Multiple daily injections and no basal insulin N = 30
				1-2 injections N = 19
				<i>P</i> *
Carbohydrate counting, n (%)				
Taught and use sometimes	12 (12)	6 (14)	1 (11)	4 (13)
				1 (5)
Taught but never use	52 (52)	26 (62)	6 (67)	13 (43)
				7 (37)
Never taught	36 (36)	10 (24)	2 (22)	13 (43)
				11 (58)
Eating plan, n (%)				
Given and use sometimes	32 (32)	16 (38)	1 (11)	11 (37)
				4 (21)
Given but never use	40 (40)	17 (40)	5 (56)	12 (40)
				6 (32)
Never given	28 (28)	9 (21)	3 (33)	7 (23)
				9 (47)

SMBG, self-monitoring of blood glucose.

* *P* value from chi-squared test.

Estimated nutrient and food group intakes, adjusted for age and occupation, across groups of diabetes nutrition therapy among individuals with Type 1 diabetes in China

Table 3

	Ever met with a dietitian			Individual or group education in preceding 12 months that covered nutrition		
	Yes n = 52 Mean (SE)	No n = 48 Mean (SE)	P *	Yes n = 18 Mean (SE)	No n = 82 Mean (SE)	P *
Nutrients						
Fat, % kcal	36.2 (1.2)	35.6 (1.2)	0.72	37.6 (1.9)	35.5 (0.9)	0.33
Carbohydrate, % kcal	46.6 (1.2)	47.5 (1.2)	0.64	45.3 (2.0)	47.5 (0.9)	0.34
Protein, % kcal	16.8 (0.4)	15.8 (0.4)	0.13	16.4 (0.7)	16.3 (0.3)	0.83
Fibre, g/1000 kcal	7.6 (0.4)	7.4 (0.4)	0.72	7.6 (0.6)	7.5 (0.3)	0.82
Iron, mg/1000 kcal	11.9 (0.4)	10.5 (0.4)	0.007	12.0 (0.6)	11.0 (0.3)	0.12
Food groups, g/1000 kcal						
Rice	81 (7.9)	78 (7.5)	0.81	77 (13)	80 (5.8)	0.86
Wheat	111 (11)	103 (10)	0.62	107 (17)	107 (8)	0.99
Beans	44 (6.5)	46 (6.3)	0.85	48 (10)	45 (4.8)	0.79
Vegetables	274 (21)	241 (20)	0.26	329 (32)	241 (15)	0.02
Fruit	42 (8.8)	55 (8.4)	0.32	48 (14)	49 (6.5)	0.96
Red meat	47 (4.9)	41 (4.7)	0.38	54 (7.8)	42 (3.6)	0.15
Eggs	37 (3.1)	27 (2.9)	0.03	34 (5.0)	31 (2.3)	0.51
Dairy	145 (14)	130 (13)	0.45	146 (22)	136 (10)	0.66
Carbohydrate counting						
			Eating plan			
Taught and sometimes use	Taught but never use		Never taught	Given and sometimes use	Given but never use	Never given
	n = 12 Mean (SE)	n = 52 Mean (SE)	n = 36 Mean (SE)	n = 32 Mean (SE)	n = 40 Mean (SE)	n = 28 Mean (SE)
Nutrients						
Fat, % kcal	37.0 (2.4)	36.8 (1.1)	34.2 (1.3)	37.0 (1.4)	33.0 (1.3)	38.8 (1.5)
Carbohydrate, % kcal	45.8 (2.5)	46.8 (1.2)	48.0 (1.4)	46.0 (1.4)	49.6 (1.3)	44.6 (1.5)
Protein, % kcal	15.9 (0.9)	16.2 (0.4)	16.5 (0.5)	16.3 (0.5)	16.2 (0.5)	16.4 (0.6)
Fibre, g/1000 kcal	7.0 (0.7)	7.7 (0.4)	7.4 (0.4)	7.4 (0.4)	7.4 (0.4)	7.7 (0.5)
						0.85

	Carbohydrate counting			Eating plan		
	Taught and sometimes use <i>n</i> = 12 Mean (SE)	Taught but never use <i>n</i> = 52 Mean (SE)	Never taught <i>n</i> = 36 Mean (SE)	Given and sometimes use <i>n</i> = 32 Mean (SE)	Given but never use <i>n</i> = 40 Mean (SE)	Never given <i>n</i> = 28 <i>P</i> *
Iron, mg/1000 kcal	11.0 (0.8)	10.9 (0.4)	11.6 (0.4)	10.7 (0.5)	11.7 (0.4)	11.0 (0.5) 0.28
Food groups, g/1000 kcal						
Rice	81 (15)	71 (7.2)	90 (8.7)	67 (9.2)	94 (8.4)	72 (9.9) 0.10
Wheat	97 (21)	106 (9.8)	110 (12)	98 (13)	116 (11)	103 (13) 0.56
Beans	57 (13)	38 (6.0)	51 (7.2)	43 (7.8)	46 (7.2)	48 (8.4) 0.89
Vegetables	275 (41)	258 (19)	249 (23)	229 (25)	268 (23)	272 (27) 0.40
Fruit	46 (18)	48 (8.2)	51 (9.9)	64 (10)	46 (9.5)	36 (11) 0.17
Red meat	31 (9.7)	46 (4.6)	45 (5.4)	48 (5.8)	38 (5.3)	49 (6.3) 0.35
Eggs	45 (6.1)	28 (2.8)	31 (3.4)	30 (3.8)	33 (3.4)	31 (4.0) 0.85
Dairy	163 (27)	131 (13)	139 (15)	148 (16)	142 (15)	119 (17) 0.44

Mean (SE) values are adjusted for age and occupational status.

*. *P* > *F* from ANCOVA, adjusted for age and occupational status.