Macronutrients and Dietary Patterns for Glucose Control

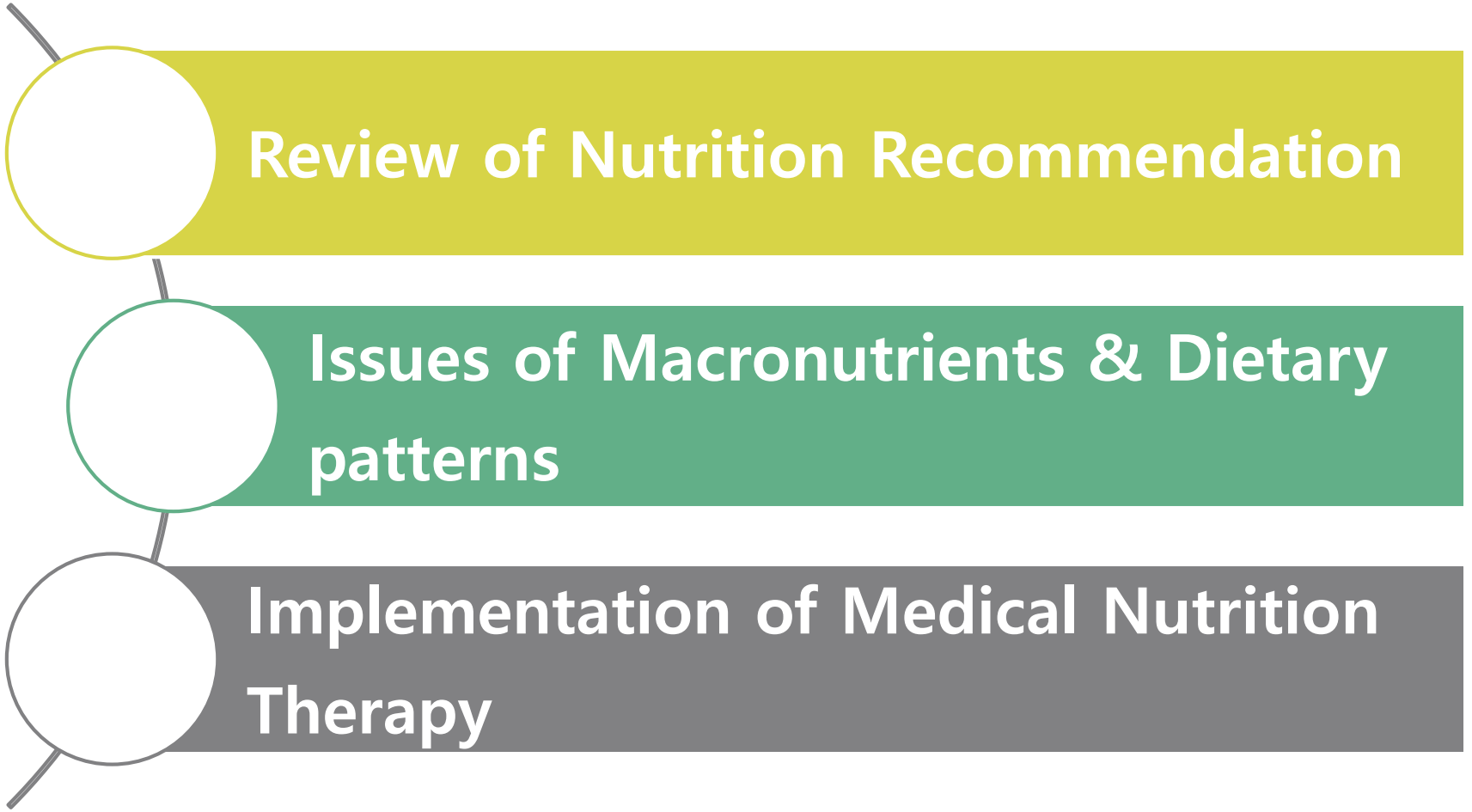
2017.5.13

서울대학교병원 임정현

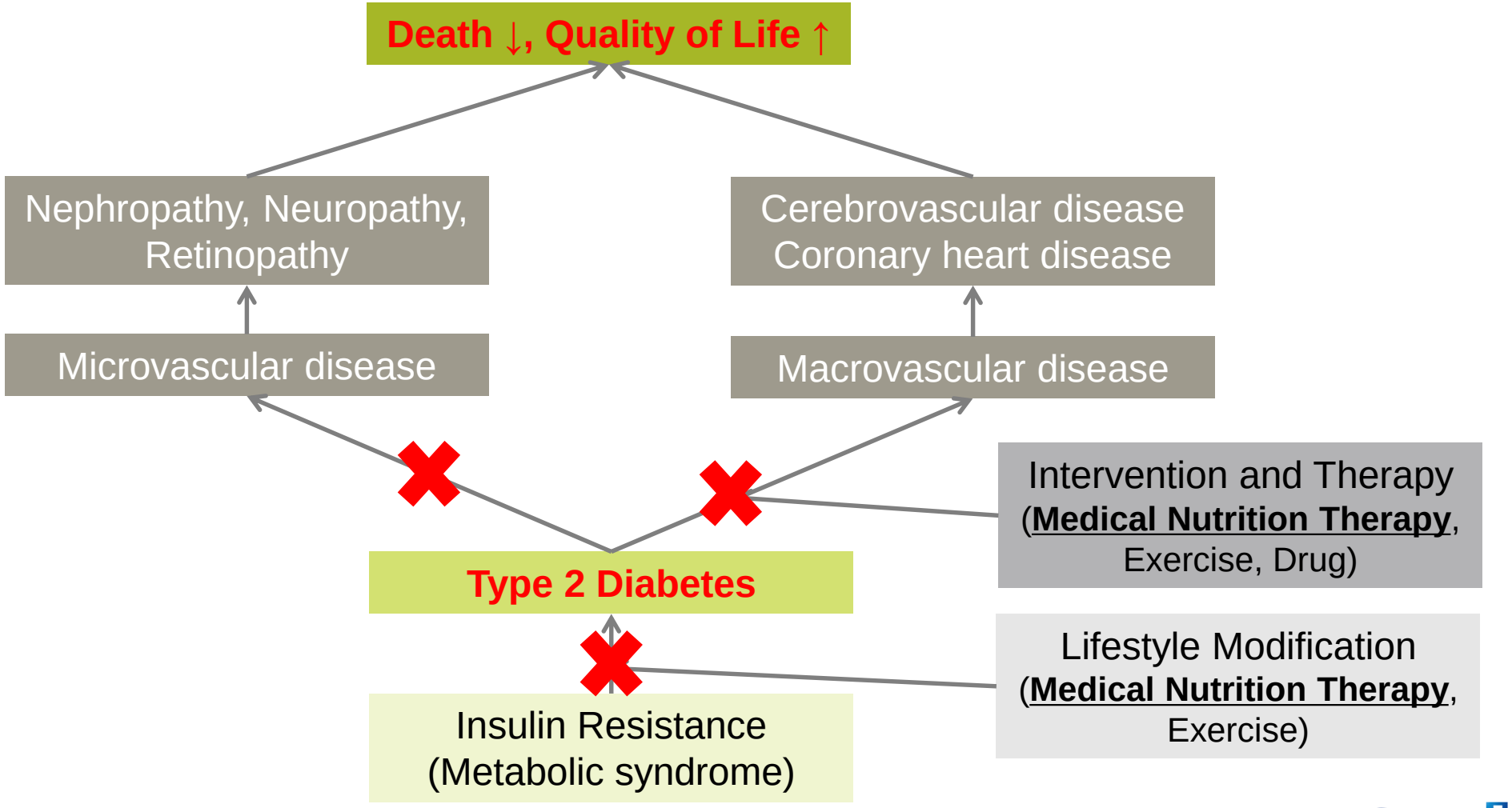
Conflict of interest disclosure

None

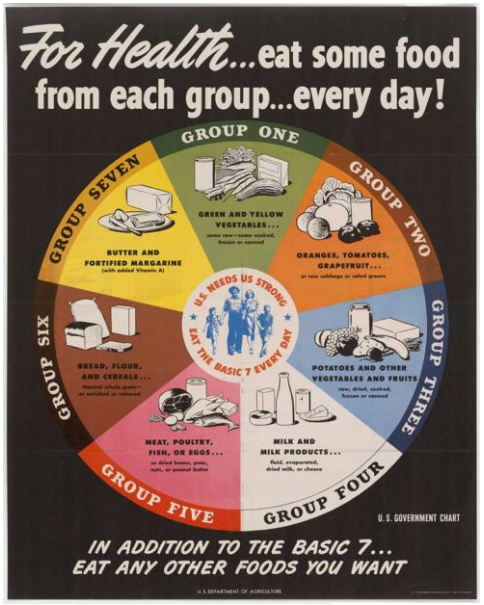
Contents


Review of Nutrition Recommendation
Issues of Macronutrients & Dietary patterns
Implementation of Medical Nutrition Therapy

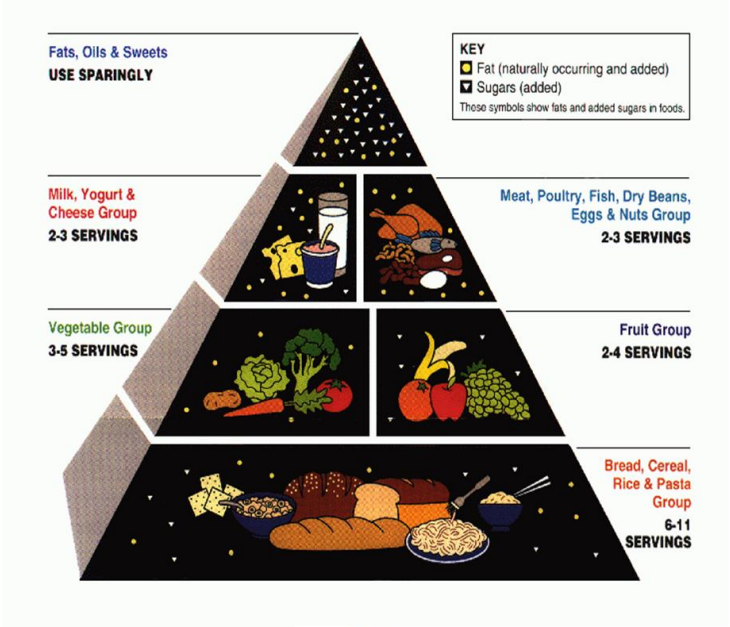
Review of Nutrition Recommendations



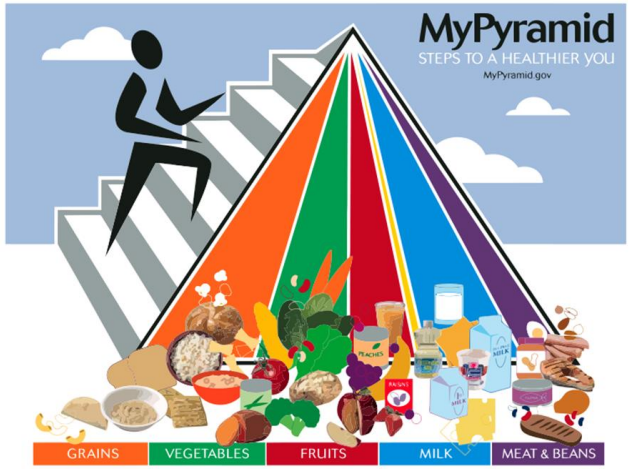
History of USDA Dietary Guidelines



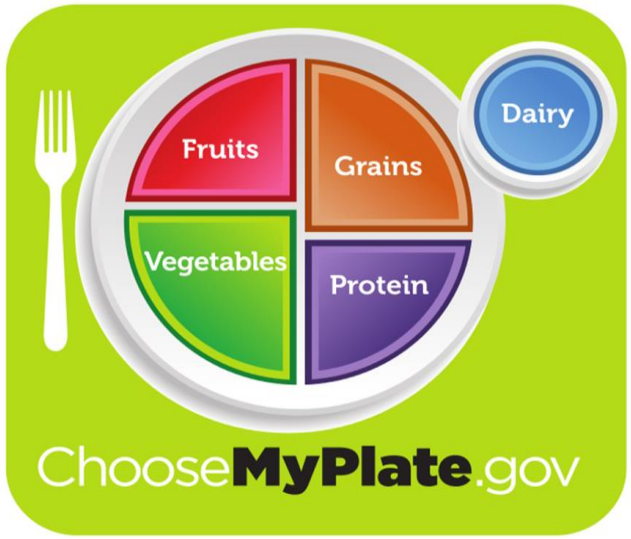
The USDA's "Basic 7" food groups from 1943 to 1956



The USDA's original "Food Pyramid" from 1992



The USDA's updated food pyramid from 2005
MyPyramid



History of Nutrition Recommendations f

- **2002 [Technical Review] [position statement]**

***Evidence-Based** Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications*

Classified according to the level of evidence available using ADA evidence grading system

Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications

- **1994, 1998 [position statement]**

Nutrition Recommendations and Principles for People with Diabetes Mellitus

- **1994 [Technical Review]**

Nutrition Principles for the Management of Diabetes and Related complications

Nutrition Recommendations and Principles for People With Diabetes Mellitus

Nutrition Principles for the Management of Diabetes and Related Complications

Nutrition Recommendations and Interventions for Diabetes

A position statement of the American Diabetes Association

Nutrition Therapy Recommendations for the Management of Adults With Diabetes

- **2013 [position statement]**

Nutrition Therapy Recommendations for the Management of Adults with Diabetes

- **2008 [position statement]**

Nutrition Recommendations and Interventions for Diabetes

서울대학교병원

The Evidence for the Effectiveness of Medical Nutrition Therapy in Diabetes Management

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Numerous advances in diabetes management and medical nutrition therapy (MNT) for individuals with diabetes make this an exciting time. Historically, a challenge to proving the benefit of MNT has been the lack of clinical and behavioral research. In recent years, however, evidence-based outcomes research that documents the clinical effectiveness of MNT in diabetes has been reported.

The term "medical nutrition therapy" was introduced in 1994 by the American Dietetic Association to better articulate the nutrition therapy process. It is defined as the use of specific nutrition services to treat an illness, injury, or condition and involves two phases: *1*) assessment of the nutritional status of the client and 2) treatment, which includes nutrition therapy, counseling, and the use of specialized nutrition supplements (1). MNT for diabetes incorporates a process that, when implemented correctly, includes: *1*) an *assessment* of the patient's nutrition and diabetes self-management knowledge and skills; 2) identification and negotiation of individually designed nutrition *goals*; *3*) nutrition *intervention* involving a careful match of both a meal-planning approach and educational materials to the patient's needs, with flexibility in mind to have the plan be implemented by the patient; and 4) *evaluation* of outcomes and ongoing monitoring. These four steps are necessary to assist patients in acquiring and maintaining the knowledge, skills, attitudes, behaviors, and commitment to successfully meet the challenges of daily diabetes self-management (2).

The primary purpose of this article is to review the evidence for the effectiveness of MNT in diabetes, both as an independent variable and in combination with other components of diabetes self-management training (DSMT). In addition, the recent studies that have demonstrated the effectiveness of lifestyle intervention, which included MNT, in preventing type 2 diabetes will be highlighted. Evidence from several studies that supports the cost-effectiveness of MNT in diabetes will also be presented.

Evidence for the clinical effectiveness of MNT in diabetes

To determine the clinical- and cost-effectiveness of MNT as a potential preventative benefit in the Medicare program, the 105th U.S. Congress, in the Balanced Budget Act of 1997, requested that a study be conducted by the Institute of Medicine (IOM) of the National Academy of Sciences. To complete their study, the IOM held a number of meetings with public testimony and presented and conducted a comprehensive literature review.

In December 1999, IOM released their report (3). In reference to diabetes, the report concluded that evidence exists demonstrating that MNT can improve clinical outcomes while possibly decreasing the cost of managing diabetes to Medicare. In conclusion, the IOM recommended to Congress that individualized MNT, provided by a registered dietitian with a physician referral, be a covered Medicare benefit as part of the multidisciplinary approach to diabetes care, which includes nutrition, exercise, blood glucose monitoring, and medications.

The IOM recommendation is consistent with the 2002 American Diabetes Association Position Statement "Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications," which states that, "because of the complexity of nutrition issues, it is recommended that a registered dietitian, knowledgeable and skilled in implementing nutrition therapy into diabetes management and education, be the team member providing medical nutrition therapy. However, it is essential that all team members be knowledgeable about nutrition therapy and is supportive of the person with diabetes who needs to make lifestyle changes" (4).

The evidence from randomized controlled trials, observational studies, and meta-analyses that nutrition intervention improves metabolic outcomes, such as blood glucose and HbA_{1c} levels in individuals with diabetes, is summarized in Table 1. Metabolic outcomes were improved in nutrition intervention studies, both as independent MNT and as part of overall DSMT. This evidence also suggests that MNT is most beneficial at initial diagnosis, but is effective at any time during the disease process, and that ongoing evaluation and intervention are essential.

Randomized controlled trials of MNT

The U.K. Prospective Diabetes Study (UKPDS) (5) was a randomized controlled trial that involved 30,444 newly diagnosed patients with type 2 diabetes at 15 centers. All treatment and control

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Received for publication 6 August 2001 and accepted 6 December 2001.

Abbreviations: DCCT, Diabetes Control and Complications Trial; DPP, Diabetes Prevention Program; DSMT, diabetes self-management training; IOM, Institute of Medicine; MNT, medical nutrition therapy; NPG, nutrition practice guideline; UKPDS, U.K. Prospective Diabetes Study.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

- **Evidence-based research strongly suggests that MNT provide by a registered dietitian who is experience in the management of diabetes is clinically effective**

Diabetes Care 2002:25: 608-613

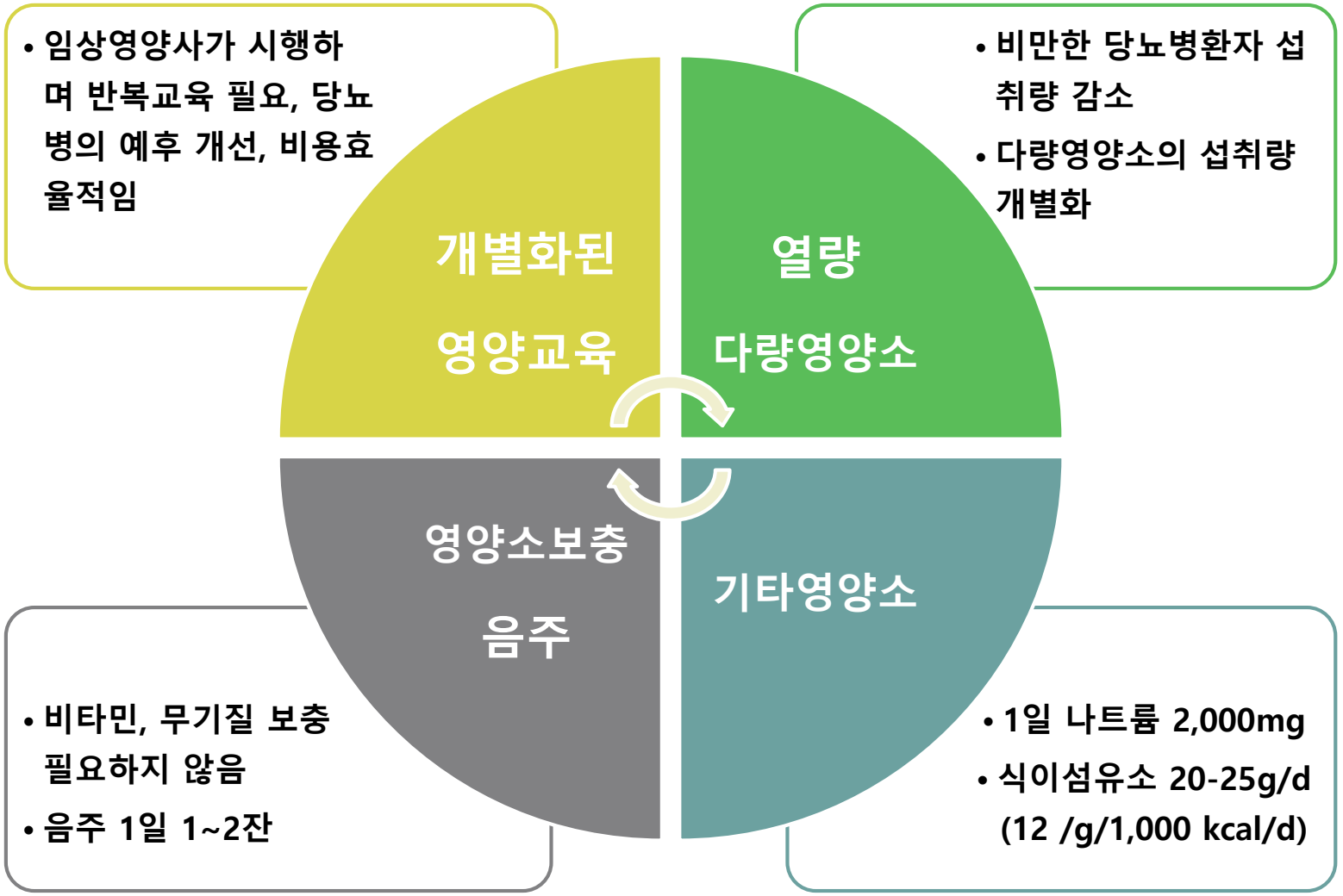
Table 1—*Summary of evidence for nutrition therapy in diabetes*

Type of intervention (Reference)	Study length	No. of subjects	Outcome
Randomized controlled trials			
MNT only			
UKPDS Group, 1990 (5)	3 months	3,042 newly diagnosed patients with type 2 diabetes	In 2,595 patients who received intensive nutrition therapy (447 were primary diet failures), HbA_{1c} decreased 1.9% (8.9 to 7%) during the 3 months before study randomization
Franz et al., 1995 (6)	6 months	179 persons with type 2 diabetes; 62 in comparison group; duration of diabetes: 4 years	HbA_{1c} at 6 months decreased 0.9% (8.3 to 7.4%) with nutrition practice guidelines care; HbA_{1c} decreased 0.7% (8.3 to 7.6%) with basic nutrition care; HbA_{1c} was unchanged in the comparison group with no nutrition intervention (8.2 to 8.4%)
Kulkarni et al., 1998 (7)	6 months	54 patients with type 1 diabetes; newly diagnosed	HbA_{1c} at 3 months decreased 1.0% (9.2 to 8.2%) with nutrition practice guideline care and 0.3% (9.5 to 9.2%) in usual nutrition care group
MNT in combination with DSMT			
Glasgow et al., 1992 (8)	6 months	162 type 2 diabetic patients over the age of 60 years	HbA_{1c} decreased from 7.4 to 6.4% in control-intervention crossover group while the intervention-control crossover group had a rebound effect; intervention group had a multidisciplinary team with an RD who provided MNT
Sadur et al., 1999 (9)	6 months	185 adult patients with diabetes	97 patients received multidisciplinary care and 88 patients received usual care by primary care. MD; HbA_{1c} decreased 1.3% in the multidisciplinary care group compared with 0.2% in the usual care group; intervention group had a multidisciplinary team with an RD who provided MNT
Observational studies			
Cross-sectional survey			
Delahanty and Halford, 1993 (10)	9 years	623 patients with type 1	Patients who reported following their meal plan >90% of the time had an average HbA_{1c} level 0.9% lower than subjects who followed their meal plan <45% of the time
Expert opinion			
DCCT Research Group, 1993 (11)			DCCT group recognized the importance of the role of the RD in educating patients on nutrition and adherence to achieve A1c goals; RD is key member of the team
Franz, 1994 (12)			DCCT made apparent that RDs and RNs were extremely important members of the team in co-managing and educating patients
Chart audit			
Johnson and Valera, 1995 (13)	6 months	19 patients with type 2 diabetes	At 6 months, blood glucose levels decreased 50% in 76 of patients receiving nutrition therapy by an RD. Mean total weight reduction was ~5 pounds
Johnson and Thomas, 2001 (14)	1 year	162 adult patients	MNT intervention decreased HbA_{1c} levels 20%, bringing mean levels <8% compared with subjects without MNT intervention who had a 2% decrease in HbA_{1c} levels
Retrospective chart review			
Christensen et al., 2000 (15)	3 months	102 patients (15 type 1 and 85 type 2 diabetic patients with duration of diabetes >6 months	HbA_{1c} levels decreased 1.6% (9.3 to 7.7%) after referral to an RD
Meta-analyses of trials			
Brown, 1996, 1990 (16, 17)		89 studies	Educational intervention and weight loss outcomes; MNT had statistically significant positive impact on weight loss and metabolic control
Padgett et al., 1988 (18)		7,451 patients	Educational and psychosocial interventions in management of diabetes (including MNT, SMBG, exercise, and relaxation); nutrition education showed strongest effect
Norris et al., 2001 (19)		72 studies	Positive effects of self-management training on knowledge, frequency and accuracy of self-monitoring of blood glucose, self-reported dietary habits, and glycemic control were demonstrated in studies with short follow-up (<6 months)

- **An individualized MNT program, preferably provided by a registered dietitian, is recommended for all people with type 1 or type 2 diabetes [A]**
- **Diabetes nutrition therapy can result in cost savings [B] and improved outcomes (e.g., A1c reduction) [A]**

Diabetes Care. 2017:40(suppl 1):S33-43

2015 Treatment Guideline Korean Diabetes Association



SNUH 서울대학교병원

2015 Treatment Guideline Korean Diabetes Association

임상영양요법

1. 당뇨병 고위험군 또는 당뇨병환자는 **임상영양사로부터 개별화된 교육을 받아야 한다.** [A] 임상영양요법은 당뇨병의 예후를 개선하며 비용대비 효과적으로 반복교육이 필요하다. [B]

2. 과체중 또는 비만한 당뇨병환자는 건강한 식습관을 유지하면서 섭취량을 줄여야 한다. [A]

3. 일반적으로 총 에너지의 50~60%를 탄수화물로 섭취하도록 권고하나, **탄수화물, 단백질, 지방 섭취량은 식습관, 기호도, 치료목표 등을 고려하여 개별화 할 수 있다.** [C]

4. 당뇨병성신증을 동반한 경우 초기부터 엄격한 단백질 제한은 필요치 않으나, 고단백질 섭취(총 에너지의 20% 이상)는 피하는 것이 좋다. [C]

2015 당뇨병진료지침, 대한당뇨병학회

SNUH 서울대학교병원

2015 Treatment Guideline Korean Diabetes Association

임상영양요법
5. 지방섭취량은 대사적 문제(비만, 이상지질혈증 등)를 고려하여 개별화하며, 포화지방과 콜레스테롤, 트랜스지방의 섭취제한은 정상인과 동일하게 할 수 있다. [C]
6. 1일 나트륨 2,000mg(소금5g)이내로 제한을 권고한다. [E]
7. 당뇨병환자에게 비타민과 무기질의 추가보충은 필요하지 않다. 단, 결핍상태이거나 제한적 식이섭취 시에는 별도로 보충한다. [B]
8. 당뇨병 예방을 위하여 식이섬유소는 전곡(whole grain)을 포함한 다양한 공급원을 통해 1일 20~25 g(12 g/1,000 kcal/day)을 섭취한다. [B]
9. 음주는 약물치료 중인 당뇨병환자에서 저혈당 발생 위험을 증가시키므로 혈당조절이 잘 되는 경우에만 1일 1~2잔 범위로 제한하며, 간질환 또는 이상지질혈증을 동반하거나, 비만한 당뇨병환자에서는 금주를 권고한다. [E]

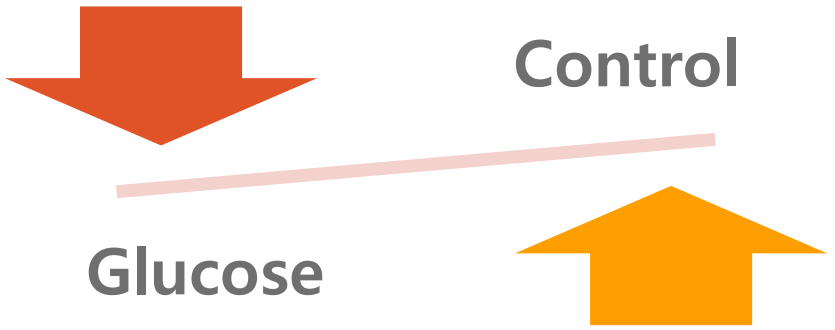
2015 당뇨병진료지침, 대한당뇨병학회

Issues of Macronutrients & Dietary patterns

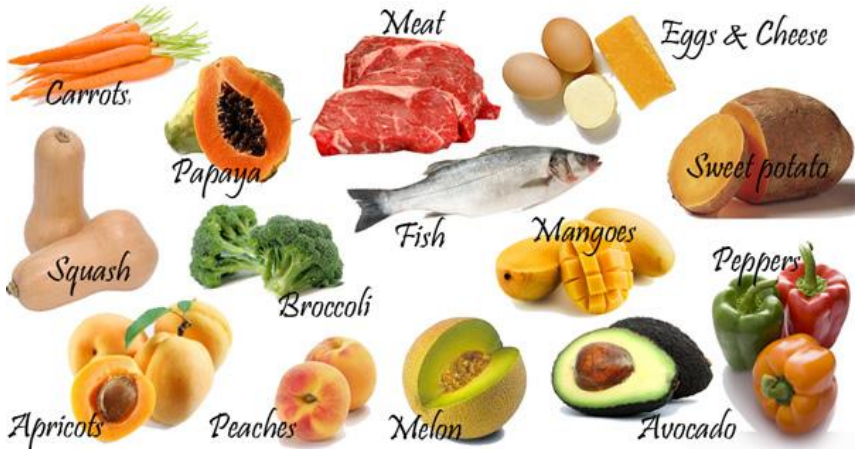
Macronutrients distribution

Food and Food Group

Eating Pattern



Overview of Studies in Nutritional Epidemiology



Nutrients intake (Na & HTN)

Foods intake (Wine & CVD)

Dietary patterns (DASH & HTN)

Metabolic Outcomes

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Issues of Macronutrients & Dietary patterns

Ideal C:P:F ratio??
60:15:25
20:30:50

1. Macronutrient Distribution

- Evidence suggests that there **is not an ideal percentage of calories** from carbohydrate, protein, and fat for all people with diabetes [B]; therefore, macronutrient distribution should be based on individualized assessment of current eating patterns, preferences, and metabolic goals [E]

Diabetes Care. 2013:36:3821-3842

- As **there is no single ideal dietary distribution of calories Among carbohydrates, fats, and proteins for people with diabetes**, **macronutrient distribution should be individualized** while keeping total calories and metabolic goals in mind. [E]

Diabetes Care. 2017:40(suppl 1):S33-43

- **1994, 1998 [position statement]**

Nutrition Recommendations and Principles for People with Diabetes Mellitus

- **1994 [Technical Review]**

Nutrition Principles for the Management of Diabetes and Related complications

Table 1—*Historical perspective of nutrition recommendations*

Year	Distribution of Calories %Carbohydrate	%Protein	%Fat
Before 1921		Starvation diets	
1921	20	10	70
1950	40	20	40
1971	45	20	35
1986	up to 60	12–20	<30
1994	*	10–20	*, †

*Based on nutritional assessment and treatment goals. †Less than 10% of calories from saturated fats.

Diabetes Care. 1994;17(5): 519-22

- **Nutrition Recommendation Dilemma**

High CHO (60% of calories) Low-fat (20~25% of calories) diets may aggravate hypertriglyceridemia, reduce HDL cholesterol and increase postprandial glycemia and insulinemia in people with Type 2 Diabetes while LDL cholesterol levels either do not change or decrease

TABLE 1

Recommendations for medical nutrition therapy for people with diabetes[1] **(1992~2002)**

Variables	BDA (19)	ADA (22)	EASD (21)	CDA (20)	Japan (24)	South Africa (25)	India (23)	AHA (26)	NCEP (27)
Carbohydrates (%)	50–55	50–60	45–60	50–60	60	55–60	>65	45–55	50–60
GI (%)	—	Not recommended for general use	Recommended	Recommended	Recommended	Recommended	—	—	—
Fiber	<30 g/d	No specific amount	Increase with low-GI foods	25–35 g/d	1 fruit, 400 g vegetables	40 g/d	No specific amount	≥25 g/d	20–30 g/d
Protein (%)	10–15	15–20	10–20	11	15–20	12–20	No specific amount	15	15
Fat (%)	30–35	25–35	≤35	≤30	20–25	<30	<21	<30	25–35

[1] ADA, American Diabetes Association; AHA, American Heart Association; BDA, British Diabetic Association; CDA, Canadian Diabetes Association; EASD, European Association for the Study of Diabetes; GI, glycemic index; NCEP, National Cholesterol Education Program.

Am J Clin Nutr. 2013;97: 505-516

Macronutrient Distribution for Glucose Control

The Use of low-carbohydrate diet in type 2 diabetes – benefits and risks

Ann Agric Environ Med. 2014:21(2):320-326

Table 1. Examples of low-carbohydrate diets

Type of diet	Content (%) of nutrients
Atkins Diet	3–16% – carbohydrates 28–64% – protein 55–65% – fats
Kwasniewski's Diet	9.2% – carbohydrates 14% – protein 76.8% – fats
Zone Diet	40% – carbohydrates 30% – protein 30% – fats

Table 2. Comparison of selected studies on effect of low carbohydrate diets used by patients with type 2 diabetes

Study author	Duration of tested diet	Carbo-hydrate count on tested diet/day	Quantity of FAT in tested diet/day/limits	Favour-able changes in HbA1c	Favour-able changes in profile of lipids	Influ-ence on body weight
Gutierrez et al.,1998	8 weeks	25% of daily energy demand	30% of daily energy demand	+	No data	+
Robertson & Broom, 2002	12 months	≤ 40g	No data	+	No data	+
Boden et al., 2005	14 days	21g	No restrictions	+	TRIGL ↓	+
Yancy et al., 2005	4 months	≤<< 20	No restrictions	+	TRIGL ↓	+
Nielsen et al., 2006	6 months	75-95g	Fats represent 50% of energy demands by the daily intake of 600-1800 kcal	+	HDL ↑	+
Westman et al., 2008	24 weeks	≤ 20g	No data	+	HDL ↑	+

+ – positive impact; ↑ – increase; ↓ – decrease; TRIGL – triglycerides; HDL – high density lipoprotein

Macronutrient Distribution for Glucose Control

Dietary carbohydrate restriction as the first approach in diabetes management: Critical review and evidence base

Nutrition. 2015:31:1-13

Table 1
Suggested definitions for different Forms of low-carbohydrate diets*

Very low-carbohydrate ketogenic diet (VLCKD)
- Carbohydrate, 20–50 g/d or <10% of the 2000 kcal/d diet, whether or not ketosis occurs. Derived from levels of carbohydrate required to induce ketosis in most people.
- Recommended early phase ("induction") of popular diets such as Atkins Diet or Protein Power.

Low-carbohydrate diet: <130 g/d or <26% total energy
- The ADA definition of 130 g/d as its recommended minimum.

Moderate-Carbohydrate Diet: 26%–45%
- Upper limit, approximate carbohydrate intake before the obesity epidemic (43%).

High-Carbohydrate Diet: >45%
- Recommended target on ADA websites.
- The 2010 Dietary Guidelines for Americans recommends 45%–65% carbohydrate. The average American diet is estimated to be ~49% carbohydrate.
- Carbohydrate Consumption (NHANES)†:
  - Men
    - 1971–1974: 42% (~250 g for 2450 kcal/d)
    - 1999–2000: 49% (~330 g for 2600 kcal/d)
  - Women
    - 1971–1974: 45% (~150 g for 1550 kcal/d)
    - 1999–2000: 52% (~230 g for 1900 kcal/d)

Macronutrient Distribution for Glucose Control

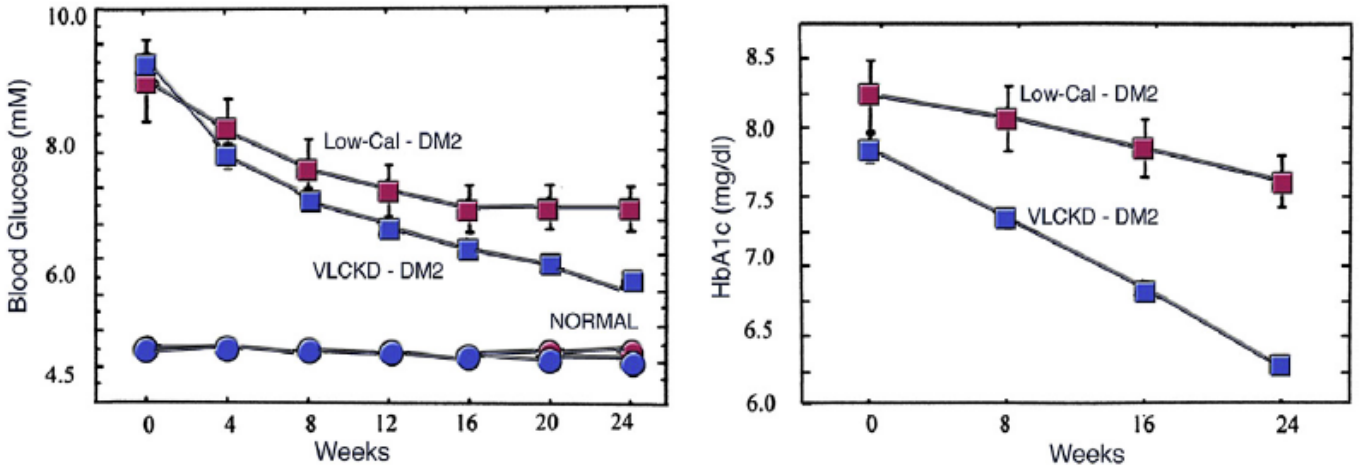


Fig. 1. Effect of low-calorie versus low-carbohydrate ketogenic diet in type 2 diabetes.

Nutrition. 2015:31:1-13

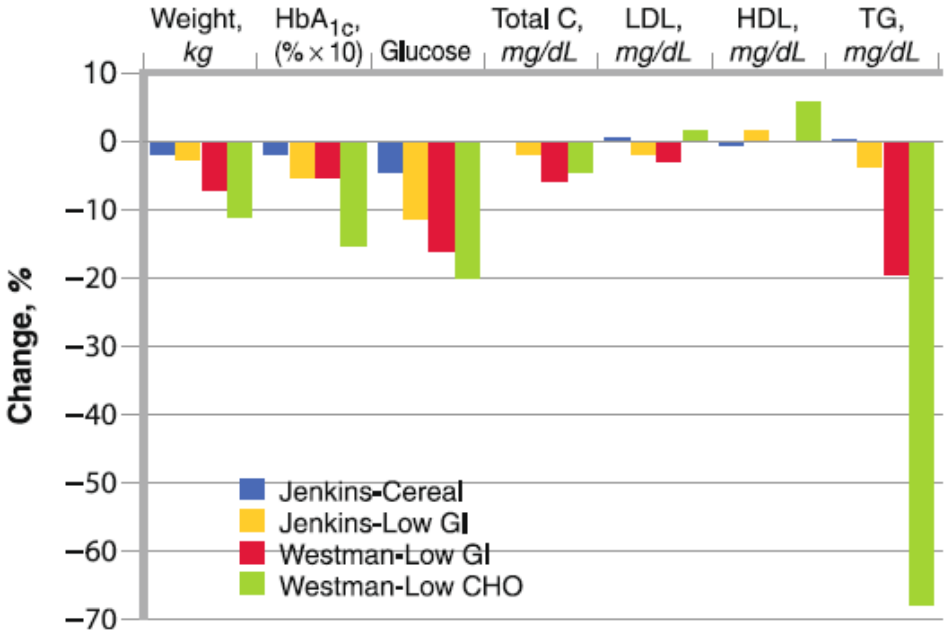


Fig. 2 Comparison of cereal-based diets and low-GI diets of Jenkins et al. [16] and comparison of low-GI diets with low-carbohydrate diets of Westman et al. [17]. Changes are shown as percentage for the indicated parameters. C—cholesterol; CHO—carbohydrate; GI—glycemic index; HbA_{1c}—hemoglobin A_{1c}; HDL—high-density lipoprotein; LDL—low-density lipoprotein; TG—triglyceride

Curr Diab Rep. 2011:11:128-135

Macronutrient Distribution for Glucose Control

Macronutrients, Food Groups, and Eating Patterns in the Management of Diabetes – A systematic review of the literature, 2010

Diabetes Care. 2012:35;434-445

- very-low-carbohydrate diet: 21–70 g/day of carbohydrate
- moderately low–carbohydrate diet: 30 to <40% of kcal as carbohydrate
- moderate-carbohydrate diet: 40–65% of kcal as carbohydrate
- high-carbohydrate diet: >65% of kcal as carbohydrate

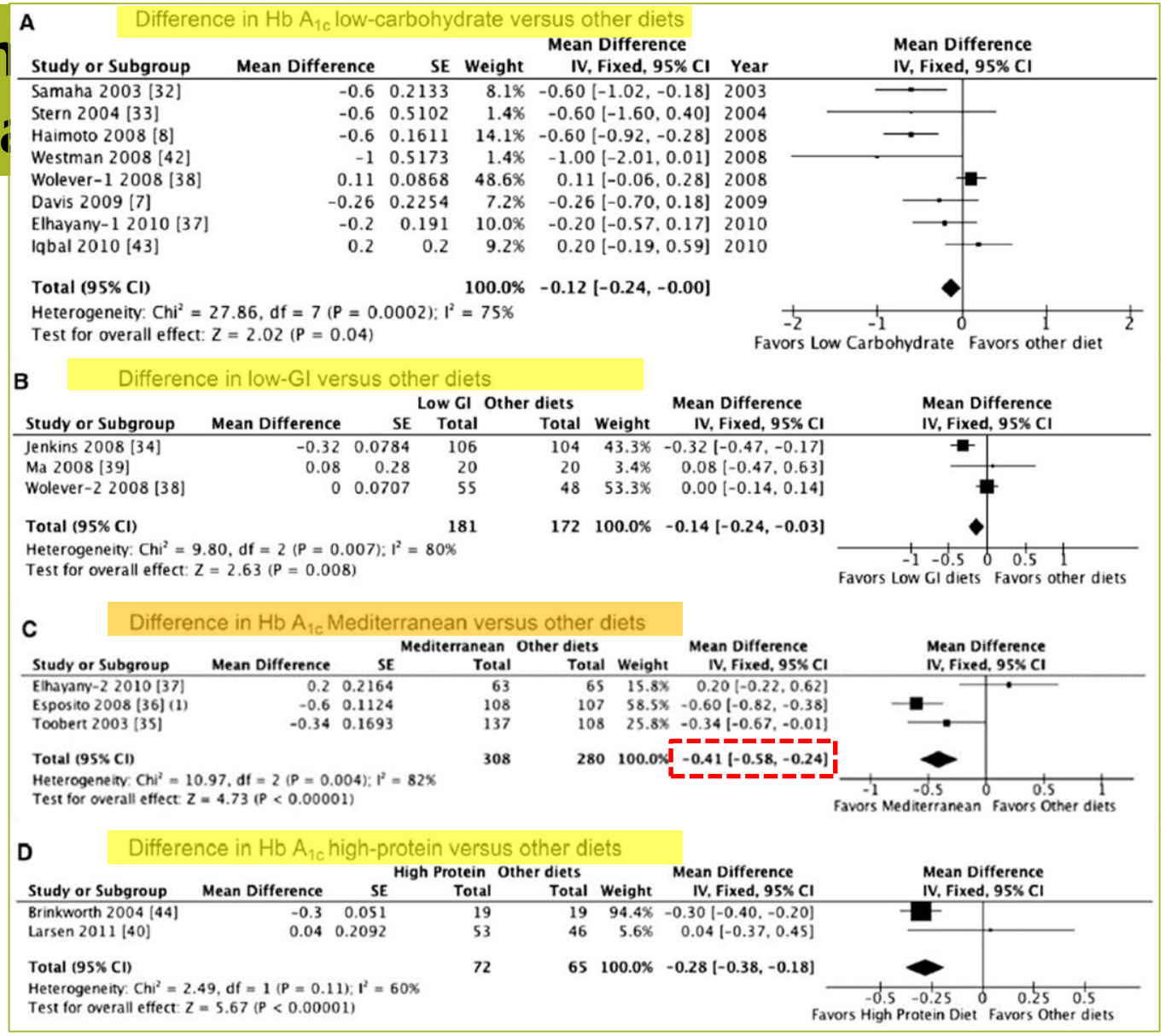
▪ **Lower (very low and moderately low) carbohydrate**

In studies reducing total carbohydrate intake, markers of glycemic control and insulin sensitivity improved, but studies small, of short duration, and in some cases were not randomized or had high dropout rates

Macronutrient Distribution for Glucose Control

Systematic review and n
approaches to the ma

The **low-carbohydrate, low-GI, Mediterranean and high protein diets** all led to a greater improvement in glycemic control compared with their respective control diets, with the **largest effect** size seen in the **Mediterranean diet**



Am J Clin Nutr, 2013;97: 505-516

Macronutrient Distribution for Glucose Control

The effect of ma
randomized contr
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Only four studies reported a significant differe in HbA1c betwee different dietary interventions des a non-significant difference in weig loss

References	Participants	HbA1c (%) at baseline		Intervention (*n* per arm)	Composition of prescribed diets	Mean weight loss (kg)	Mean decrease in HbA1c (%)	Duration	Attrition rate	Medication	Conclusion
		Mean	SD								
Esposito *et al.*[10]	215 overweight adults with type 2 diabetes	7·73		LCMD (107) *v.* LFD (108)	LCMD: 50 % CHO, 20 % protein, no <30 % fat LFD: no >30 % fat with no >10 % SFA	3·8 (SD 2) *v.* 3·2 (SD 1·9) authors stated no significant difference between groups (no *P* value reported)	0·9 (SD 0·6) *v.* 0·5 (SD 0·4) authors stated significant differences between groups (no *P* value reported)	4 years	9·3 %	After 4 years 44 % of participants in the LCMD and 70 % of those in the LFD group required treatment (absolute difference, −26·0 percentage points (95 % CI 0·51, 0·86), hazard ratio adjusted for weight change, 0·70 (95 % CI 0·59, 0·90); *P*< 0·001).	LCMD appears to be more effective in reducing HbA1c compared with a LFD with less need for glucose-lowering medication
Fabricatore *et al.*[9]	79 obese adults with type 2 diabetes	6·8		Low fat (39) *v.* low GL (40)	Low fat: <30 % fat Low GL: 3 or less servings of moderate-GL and 1 or less serving of high-GL foods/d	4·5 (SD 0·34) *v.* 6·4 (SD 0·52) (*P*= 0·28)	0·1 (SD 0·0012) *v.* 0·8 (SD 0·0104): significant difference between groups (*P*= 0·01)	40 weeks	36·7 %	Authors stated that changes in HbA1c were adjusted for medication use. Percentage of participants who increased, decreased or did not change their diabetic medication regime did not differ between the groups at week 20 (*P*= 0·51) or at week 40 (*P*= 0·70)	Low GL appears to be more effective in reducing HbA1c compared with a the LFD
Elhayany *et al.*[12]	259 overweight and obese adults with type 2 diabetes	8·3		LCMD (61) *v.* TM diet (63) *v.* ADA diet (55)	LCM: 35 % low-GI CHO, 15–20 % protein, 45 % fat rich in MUFA TM: 50–55 % low-GI CHO, 15–20 % protein, 30 % fat rich in MUFA ADA: 50–55 % CHO, 15–20 % protein, 30 % fat	10·1 *v.* 7·4 *v.* 7·7 authors stated no significant difference between groups (no *P* value reported)	2·0 *v.* 1·8 *v.* 1·6 significant difference between diets (*P*= 0·021), LCM different than ADA, TMD different than ADA	12 months	30·9 %	Authors do not mention baseline medication characteristics or any changes in glucose-lowering medication use during the course of the intervention	LCM diet appears to be more effective in reducing HbA1c compared with a TM and ADA diets
Barnard *et al.*[13]	99 obese adults with type 2 diabetes	7·99		Low-fat vegan diet (49) *v.* ADA diet (50)	Low-fat vegan diet: 75 % CHO, 15 % protein, 10 % fat ADA: 60–70 % CHO, 15–20 % protein and MUFA	4·4 (SD 0·9) *v.* 3·0 (SD 0·8) (*P*= 0·25)	0·34 (SD 0·19) *v.* 0·14 (SD 0·17) no significant difference between groups (*P*= 0·43) 0·4 % *v.* 0·01 % (*P*= 0·03) when adjusted for medication	74 weeks	18·4 % for the vegan group 14 % for the ADA group	Net 74-week dosages were reduced in 35 % participants in vegan group and 20 % of those in the ADA group, and were increased in 14 % of vegan group and 24 % of conventional group	Once data are adjusted for medication use, there appears to be a significant benefit in the low-fat vegan diet in decreasing HbA1c compared with the ADA diet

Br J Nutr. 2015;114: 1656-1666

Macronutrient Distribution for Glucose Control

Lifestyle Weight-Loss Intervention Outcomes in Overweight and Obese Adults with Type 2 Diabetes: A systematic Review and Meta-Analysis of Randomized Clinical Trials

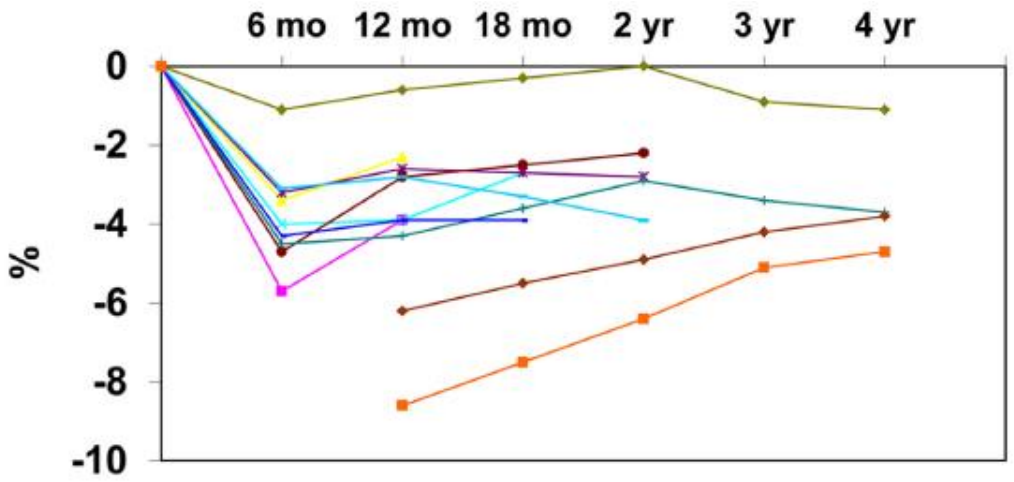

Figure 2. Mean percentage of weight loss/maintenance in individuals with type 2 diabetes f
terventions (19 weight-loss intervention study groups with 10 categories of weight-loss interve

Study group	12-month difference	SE[a]	Weight (%)	Mean difference (95% CI)
Brehm[18] High MUFA[b]	0.1	0.10	9.4%	0.1 (-0.09, 0.29)
Brehm[18] High CHO[c]	0	0.11	6.7%	0 (-0.21, 0.21)
Davis[19] Low CHO	-0.02	0.13	5.1%	-0.02 (-0.28, 0.24)
Davis[19] Low Fat	0.24	0.22	2.1%	0.24 (-0.19, 0.67)
Esposito[20] Low-fat	-0.6	0.06	11.2%	-0.6 (-0.71, -0.48)
Gulbrand[23] Low Fat	0.1	0.52	0.5%	0.1 (-0.92, 1.12)
Gulbrand[23] Low CHO	-0.2	0.57	0.4%	-0.2 (-1.3, 0.9)
Krebs[22] High Protein	-0.1	0.10	2.5%	-0.1 (-0.3, 0.1)
Krebs[22] High CHO	-0.2	0.10	2.5%	-0.2 (-0.39, 0)
Larsen[21] High CHO	-0.28	0.15	4.0%	-0.28 (-0.56, 0)
Larsen[21] High Protein	-0.23	0.15	3.3%	-0.23 (-0.52, 0.06)
Li[16] Meal Replacements	-0.3	0.07	19.5%	-0.3 (-0.43, -0.16)
Li[16] Reduced Energy Intake	-0.15	0.08	19.5%	-0.15 (-0.29, 0)
Metz[14] Meal Replacements	-0.24	0.24	1.8%	-0.24 (-0.7, 0.22)
West[17] Group + Motivational Interviewing	-0.44	0.08	5.9%	-0.44 (-0.6, -0.27)
West[17] Group Behavioral	-0.62	0.11	3.4%	-0.62 (-0.84, -0.39)
Wolf[15] Reduced Energy Intake	-0.2	0.19	2.1%	-0.2 (-0.57, 0.17)
12-month Wt loss <5%	**-0.224**			**-0.224 (-0.64, 0.19)**
Esposito[20] Med-Style	-1.25	0.09	44.3%	-1.25 (-1.42, -1.07)
Look AHEAD[10] Intensive Lifestyle	-0.64	0.02	55.7%	-0.64 (-0.67, -0.6)
12-month Wt loss ≥5%	**-0.91**			**-0.91 (-2.3, 0.48)**
Look AHEAD [10] Diabetes Education	-0.12	0.02	60.2%	-0.12 (-0.15, -0.08)
Metz[14] Usual Care	-0.2	0.18	28.0%	-0.2 (-0.55, 0.15)
Wolf[15] Usual Care	0	0.25	11.8%	0 (-0.49, 0.49)
Usual Care/Control	**-0.128**			**-0.128 (-1.56, 1.31)**

Test for heterogeneity: Q=2.39, df=21, I^2=777%

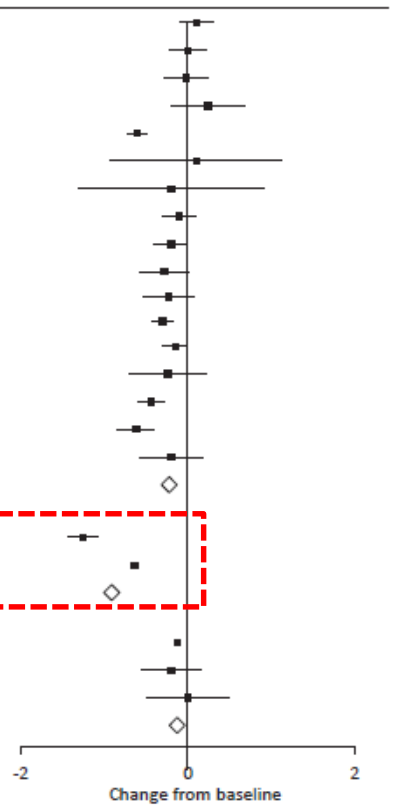

Figure 3. Forest plot for hemoglobin A1c (HbA1c) (%) change from baseline to 12 months in weight-loss intervention trials in overweight and obese adults with type 2 diabetes. [a]SE=standard error. [b]MUFA=monounsaturated fatty acids. [c]CHO=carbohydrate.

J Acad Nutr Diet. 2015:115:1447-1463

Macronutrient Distribution for Glucose Control

Lifestyle Weight-Loss Intervention Outcomes in Overweight and Obese Adults with Type 2 Diabetes: A systematic Review and Meta-Analysis of Randomized Clinical Trials

- The majority of lifestyl
loss interventions in ov
or obese adults with ty
diabetes resulted in we
<5% and did not resul
beneficial metabolic ou

- Weight loss for many
or obese individuals w
diabetes might not be
primary treatment stra
improved glycemic cor

Table 2. Lifestyle weight-loss intervention trials in overweight and obese adults with type 2 diabetes comparing differing macronutrient compositions: Recommended and reported macronutrient percentages and daily calorie intake, mean weight loss, and mean change in hemoglobin A1c levels at 12 months

Weight-loss intervention	Author(s), no. of subjects	Recommended macronutrient (carbohydrate, protein, fat), % and daily calorie deficit	Reported macronutrient intake at 12 mo (carbohydrate, protein, fat), %	Reported kcal/day intake at 12 mo (calorie deficit)	Weight loss, kg, mean±SD[a] at 12 mo (%)	Change in hemoglobin A1c, % mean±SD at 12 mo
High CHO[b]	Brehm and colleagues,[18] n=62	60, 15, 25; −200 to 300 kcal/day	54, 18, 28	1,550 (−330)	−3.8±4.3 (3.7)	0±0.8
	Larsen and colleagues,[21] n=46	55, 15, 30; 3-mo −30% kcal (~1,500 kcal/day), 9-mo energy balance	49, 19, 32	1,580 (−610)	−2.2±4.3 (2.3)	−0.3±1.0
	Krebs and colleagues,[22] n=212	55, 15, 30; −500 kcal/day	48, 21, 31	1,620 (−255)	−2.4 ± 6.6 (2.3)	−0.2±1.1
Low CHO	Davis and colleagues,[19] n=50	20 to 25 g/day CHO for 2 wk; Atkins diet thereafter	33, 23, 44	1,640±600 (−340)	−3.1±4.8 (3.3)	0±0.9
	Gulbrand and colleagues,[23] n=30	20, 30, 50; 1,600 kcal/day for women, 1,800 kcal/day for men	28, 24, 48	1,440 (−250)	−1.9±12.0 (2.0)	−0.2±1.4
Low fat	Davis and colleagues,[19] n=50	25 fat; modeled after the Diabetes Prevention Program	50, 19, 31	1,810±590 (−50)	−3.1±5.8 (3.0)	+0.2±1.5
	Gulbrand and colleagues,[23] n=31	50, 20, 30; 1,600 kcal for women, 1,800 kcal for men	48, 20, 32	1,580 (−225)	−3.9±5.9 (4.3)	+0.1±0.9
High protein	Larsen and colleagues,[21] n=53	40, 30, 30; 3-mo −30% kcal (~1,500 kcal/day), 9-mo energy balance	42, 27, 31	1,590 (−530)	−2.2±3.8 (2.3)	−0.2±1.1
	Krebs and colleagues,[22] n=207	40, 30, 30; −500 kcal/day	45, 22, 33	1,730 (−150)	−3.2±6.6 (3.0)	−0.1±1.0
High MUFA[c]	Brehm and colleagues,[18] n=62	45, 15, 40 (20 MUFA); 200 to 300 kcal/day	46, 16, 38 (14 MUFA)	1,550 (−350)	−4.0±5.2 (3.9)	+0.1±0.8

J Acad Nutr Diet. 2015:115:1447-1463

Issues of Macronutrients & Dietary patterns

2. Food and Food Group

- Carbohydrate intake from **whole grains, vegetables, fruits, legumes, and dairy products,** with an emphasis on food higher in fiber and lower in glycemic load, should be advised over other sources, especially those containing sugars. [B]

- People with diabetes and those at risk should **minimize the consumption of foods with added sugar** that have the capacity to displace healthier, **more nutrient-dense food choices**. [A]

Foods high in added sugars (such as sodas and sweets) are nutritionally inferior to foods with naturally occurring sugar (such as fruit and milk)

American Diabetes Association. Standard of medical care in diabetes-2017, 4. Lifestyle Management, Diabetes Care. 2017:40(suppl 1):S33-43

Food and Food Group for Glucose Control

Macronutrients, Food Groups, and Eating Patterns in the Management of Diabetes – A systematic review of the literature, 2010

Diabetes Care. 2012:35;434-445

- **Whole grains** : whole-grain consumption does not appear to be associated with improved glycemic control
- **Vegetables and fruit** : eating pattern research has not directly addressed the role of vegetables and fruits
- **Legumes** : most studies did not indicate a significant reduction in glycemic measures
- **Dairy** : none of components of dairy appear to have an effect on glycemic control
- **Nuts** : nut-enriched diets do not alter glycemia
- **Meats, poultry, and fish** : there is limited evidence to provide conclusive statements relating to the intake of meat, poultry, and fish

- **Research involving diabetes and food groups is sparse and does not indicate an advantage for specific foods in improving glycemic control**

Issues of Macronutrients & Dietary patterns

3. Eating Patterns

New ADA Guidelines Focus on 'Eating Patterns', not 'Diet'

Medscape Medical News, http://www.medscape.com/viewarticle/812795, 2013

Since people eat food and not single nutrients such as carbohydrates, protein and fat, the report includes a new section on eating patterns

- A variety of eating patterns are acceptable for the management of type 2 diabetes and prediabetes including **Mediterranean, DASH, and plant-based diets** [B]

American Diabetes Association. Standard of medical care in diabetes-2017, 4. Lifestyle Management, Diabetes Care. 2017:40(suppl 1):S33-43

Eating Patterns for Glucose Control

Macronutrients, Food Groups, and Eating Patterns in the Management of Diabetes – A systematic review of the literature, 2010

Diabetes Care. 2012;35;434-445

- **Mediterranean-style eating pattern**
  - There appears to be no advantage in using the Mediterranean-style eating pattern compared with other eating patterns for glycemic control.
  - Individual components of the Mediterranean-style eating pattern(wine, high MUFA/olive oil) do not appear to have independent effects on glycemic control

- **Vegetarian eating pattern**
  - Research is limited regarding vegetarian eating pattern.
  - Because of methodological problems, more research is needed before conclusive remarks can be made about the associations between a vegetarian eating pattern and glycemic control

- **2013 [position statement]**

Nutrition Therapy Recommendations for the Management of Adults with Diabetes

Diabetes Care, 2013;36: 3821-3842

Table3 - Reviewed eating patterns

Type of eating pattern	Description
Mediterranean style (96)	Includes abundant plant food (fruits, vegetables, breads, other forms of cereals, beans, nuts and seeds); minimally processed, seasonally fresh, and locally grown foods; fresh fruits as the typical daily dessert and concentrated sugars or honey consumed only for special occasions; olive oil as the principal source of dietary lipids; dairy products (mainly cheese and yogurt) consumed in low to moderate amounts; fewer than 4 eggs/week; red meat consumed in low frequency and amounts; and wine consumption in low to moderate amounts generally with meals.
Vegetarian and vegan (97)	The two most common ways of defining vegetarian diets in the research are vegan diets (diets devoid of all flesh foods and animal-derived products) and vegetarian diets (diets devoid of all flesh foods but including egg [ovo] and/or dairy [lacto] products). Features of a vegetarian-eating pattern that may reduce risk of chronic disease include lower intakes of saturated fat and cholesterol and higher intakes of fruits, vegetables, whole grains, nuts, soy products, fiber, and phytochemicals.
Low fat (98)	Emphasizes vegetables, fruits, starches (e.g., breads/crackers, pasta, whole grains, starchy vegetables), lean protein, and low-fat dairy products. Defined as total fat intake <30% of total energy intake and saturated fat intake <10%.
Low carbohydrate (88)	Focuses on eating foods higher in protein (meat, poultry, fish, shellfish, eggs, cheese, nuts and seeds), fats (oils, butter, olives, avocado), and vegetables low in carbohydrate (salad greens, cucumbers, broccoli, summer squash). The amount of carbohydrate allowed varies with most plans allowing fruit (e.g., berries) and higher carbohydrate vegetables; however, sugar-containing foods and grain products such as pasta, rice, and bread are generally avoided. There is no consistent definition of "low" carbohydrate. In research studies, definitions have ranged from very low-carbohydrate diet (21–70 g/day of carbohydrates) to moderately low-carbohydrate diet (30 to <40% of calories from carbohydrates).
DASH (99)	Emphasizes fruits, vegetables, and low-fat dairy products, including whole grains, poultry, fish, and nuts and is reduced in saturated fat, red meat, sweets, and sugar-containing beverages. The most effective DASH diet was also reduced in sodium.

Clinical Practice Guidelines **Nutrition Therapy**

Canadian Diabetes Association Clinical Practice Guidelines Expert Committee

Table 1. Properties of dietary interventions

Properties of dietary interventions (listed in the order they are presented in the text)			
Dietary interventions	**A1C***	**Advantages**	**Disadvantages**
Macronutrients			
Hi-CHO (low-glycemic index)	↓	↑HDL-C, ↓CRP, ↓hypoglycemia, ↓diabetes medications	–
Hi-CHO (hi-fibre)	↓	↓TC, ↓LDL-C, ↓diabetes medications	↓HDL-C, GI side effects
Hi-MUFA	↓	↓TG	–
Lo-CHO	↔	↓TG	↓Micronutrients, ↑renal load
Hi-protein	↓	↓BP, ↓TG, preserve lean mass	↓Micronutrients, ↑renal load
Long chain omega 3 fatty acids	↔	↓TG	Methyl-Hg exposure, environmental impact
Dietary patterns			
Vegetarian diets	↓	↓LDL-C, ↑HDL-C, ↓BMI, ↓non-HDL-C†, ↓TC†	↓Vitamin B12
Mediterranean diets	↓	↓BP, ↓CRP, ↓TC, ↑HDL-C, ↓ TC:HDL-C, ↓TG, major CV events	–
DASH	↓	↓Weight, ↓BP, ↓CRP, ↓LDL-C, ↑HDL-C	–
Popular weight loss diets			
Atkins diet	↔	↓Weight, ↓TC, ↑HDL-C, ↓TC:HDL-C, ↓TG	↑LDL-C, ↓ micronutrients, ↓adherence, ↑renal load
Protein Power Plan	↓	↓Weight	↓ Micronutrients, ↓adherence, ↑renal load
Ornish diet	–	↓Weight, ↓LDL-C:HDL-C	↔ FPG, ↓adherence
Weight Watchers diet	–	↓Weight, ↓LDL-C:HDL-C	↔ FPG, ↓adherence
Zone diet	–	↓Weight, ↓LDL-C:HDL-C	↔ FPG, ↓adherence, ↑renal load
Diets emphasizing specific foods			
Dietary pulses	↓	↓TC, ↓LDL-C	GI side effects
Nuts	↓	↓LDL-C, ↓apo-B, ↓apo-B:apo-A1, ↓TG	–
Meal replacements	↓	↓Weight	Temporary intervention

*↓ = <1% decrease in A1C. † adjusted for medication changes.
A1C = glycated hemoglobin; BMI = body mass index; BP = blood pressure; CHO = carbohydrate; CRP = C reactive protein; CV = Cardiovascular; FPG = fasting plasma glucose; GI = gastrointestinal; HDL = high-density lipoprotein; LDL = low-density lipoprotein; MUFA = monounsaturated fatty acid; TC = total cholesterol; TG = triglycerides.

Can J Diabetes, 2013;37: S45-S55

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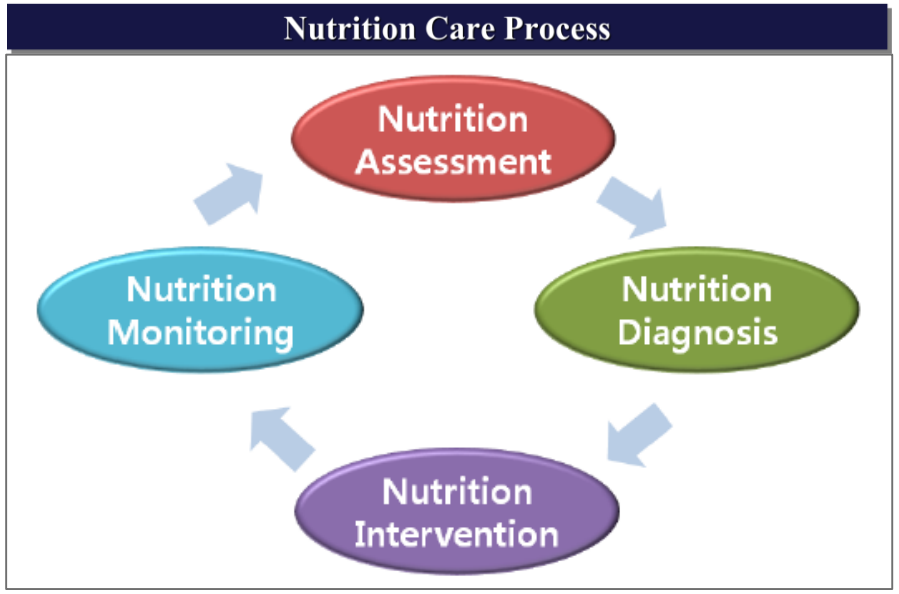
Implementation of Medical Nutrition Therapy

American Dietetic Association (**ADA**) evidence- based nutrition practice guidelines (**EBNPG**) recommendations are integrated throughout the Nutrition Care Process (**NCP**)

Academy of Nutrition and Dietetics Evidence-Based Nutrition Practice Guidelines recommended the following structure for the implementation of MNT for adults with diabetes

- A series of 3-4 encounters with an RD lasting from 45-90min.
- The series of encounters should begin at diagnosis of diabetes or at first referral to an RD for MNT for diabetes and should be completed within 3-6 months.
- The RD should determine whether additional MNT encounters are needed.
- At least 1 follow-up encounter is recommended annually to reinforce lifestyle changes and to evaluate and monitor outcomes that indicate the need for changes in MNT or medication(s); a RD should determine whether additional MNT encounters are needed.



Diabetes Care 2013:36: 3821-3842

Implementation of Medical Nutrition Therapy

Association between Dietary patterns and Blood Lipid Profiles in Korean Adults with Type 2 Diabetes

Table 2. Factor-loading matrix for dietary patterns identified by principal component analysis

Diets	Bread & Meat & Alcohol	Noodles & Seafood	Rice & Vegetables	Korean Healthy
Rice	-	-	0.75	-
Whole grains	-	-	-0.39	0.49
Breads	0.25	-0.44	-	0.29
Noodles	-	0.25	-0.52	-
Potatoes	-	-	-	-
Sugars	0.60	-	-	-
Legumes	-	-	-	0.49
Nuts	-	-	-	0.39
Vegetables	0.37	-	0.34	0.47
Kimchi	-	0.65	-	-
Mushrooms	-	0.29	-	0.28
Fruits	-	-	-	0.42
Meats	0.46	-	-	-
Eggs	0.31	0.32	0.30	-
Fishes	-	0.55	-	-
Seaweed	-	0.32	-	-
Dairy products	-	-	-	-
Oils	0.72	-	-	-
Beverages	0.30	-	-	-
Alcohols	0.35	-	-0.20	-
Seasonings	0.45	0.32	-	0.37
Others	-	-	-	-

Dietary patterns of adults with diabetes were found to be associated with blood lipid profiles. 'Korean Healthy' pattern including whole grains, legumes, vegetables, and fruits could thus improve lipid profiles among those with type 2 diabetes

J Korean Med Sci 2011; 26: 1201-1208

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Implementation of Medical Nutrition Therapy

Ideal C:P:F ??
60:15:25

Table 4. Nutrient intakes of subjects by dietary pattern

Variables	Bread & Meat & Alcohol			Noodles & Seafood			Rice & Vegetables			Korean Healthy		
	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend
Energy (kcal)	1,503.1 ± 500.0	2,137.6 ± 714.9	< 0.001	1,659.6 ± 722.1	1,963.2 ± 638.3	0.001	1,634.4 ± 683.7	2,065.9 ± 610.1	< 0.001	1,485.8 ± 571.6	2,079.8 ± 710.2	< 0.001
Protein (%)	11.9 ± 3.6	15.3 ± 4.0	< 0.001	13.7 ± 4.3	15.4 ± 4.1	0.002	14.3 ± 4.1	13.7 ± 3.5	0.015	12.5 ± 3.5	15.5 ± 4.4	< 0.001
Fat (%)	8.7 ± 5.6	18.4 ± 8.3	< 0.001	11.8 ± 7.6	14.8 ± 7.5	0.029	14.5 ± 7.5	13.4 ± 7.3	0.001	12.6 ± 8.3	14.2 ± 7.2	0.858
Carbohydrate (%)	80.2 ± 8.2	61.2 ± 14.2	< 0.001	70.6 ± 15.6	68.9 ± 12.3	0.204	67.3 ± 15.8	72.3 ± 11.0	< 0.001	71.1 ± 13.7	69.3 ± 14.8	0.033
Calcium (mg)	314.2 ± 212.7	581.5 ± 358.2	0.001	414.7 ± 309.3	622.7 ± 394.4	< 0.001	447.4 ± 314.2	510.9 ± 337.4	0.412	320 ± 216.2	623.1 ± 411.6	< 0.001
Iron (mg)	10.9 ± 9.3	16.1 ± 10.3	0.713	13.0 ± 8.9	16.8 ± 9.5	0.021	12.6 ± 9.5	15.7 ± 10.5	0.681	8.3 ± 4.9	20.1 ± 12.4	< 0.001
Vitamin A (μg RE)	529.8 ± 992.8	958.4 ± 771.6	0.236	597.1 ± 620.2	978.7 ± 1371.2	0.012	731.7 ± 1532.1	871.3 ± 759.5	0.560	466.8 ± 566.2	969.3 ± 1069.0	0.011
Vitamin C (mg)	79.2 ± 69.6	111.7 ± 79.0	0.341	94.8 ± 77.1	108.2 ± 65.6	0.436	77.3 ± 54.3	118.6 ± 84.6	0.001	56.8 ± 49.7	125.9 ± 76.5	< 0.001

Mean ± SD; *P* for trend after adjusted for age, gender, education, household income, smoking, physical activity, DM duration, DM treatment, BMI, and energy intake.

J Korean Med Sci 2011; 26: 1201-1208

Implementation of Medical Nutrition Therapy

Table 5. Body indices and blood profiles of subjects by dietary pattern

Variables	Bread & Meat & Alcohol			Noodles & Seafood			Rice & Vegetables			Korean Healthy		
	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend	Quartile 1	Quartile 4	*P* trend
Body mass index (kg/m^2)	25.2 ± 3.3	25.6 ± 3.5	0.551	25.3 ± 3.1	25.3 ± 3.4	0.406	25.3 ± 3.4	25.4 ± 3.3	0.934	24.9 ± 3.1	25.5 ± 3.1	0.825
Waist circumference (cm)	88.2 ± 8.7	89.4 ± 8.6	0.459	88.4 ± 8.5	88.2 ± 8.7	0.306	88.1 ± 9.0	89.2 ± 8.7	0.862	87.6 ± 8.8	88.7 ± 8.1	0.607
Fasting blood sugar (mg/dL)	148.2 ± 47.9	151.4 ± 46.9	0.655	141.9 ± 46.7	150.3 ± 45.3	0.293	143.7 ± 49.2	146.5 ± 45.8	0.779	142.8 ± 43.9	148.6 ± 53.5	0.971
Hemoglobin A1c (%)	7.5 ± 1.7	7.5 ± 1.7	0.686	7.2 ± 1.5	7.4 ± 1.5	0.555	7.4 ± 1.7	7.4 ± 1.7	0.431	7.3 ± 1.7	7.4 ± 1.8	0.822
Cholesterol (mg/dL)	191.9 ± 42.3	201.8 ± 41.8	0.002	195.1 ± 49.0	194.7 ± 40.6	0.518	198.8 ± 44.8	192.1 ± 41.1	0.784	202.5 ± 44.7	188.4 ± 40.3	0.004
Triglyceride (mg/dL)	175.9 ± 109.9	189.8 ± 125.2	0.804	177.3 ± 128.7	179.9 ± 125.8	0.864	175.2 ± 118.2	166.7 ± 104.6	0.499	188.9 ± 149.0	162.2 ± 89.2	0.030
HDL cholesterol (mg/dL)	42.9 ± 9.4	44.7 ± 10.1	0.001	43.1 ± 9.0	43.9 ± 9.0	0.347	43.6 ± 10.0	43.1 ± 8.9	0.285	44.3 ± 10.0	44.2 ± 8.8	0.674
Systolic blood pressure (mmHg)	126.9 ± 17.4	126.8 ± 17.8	0.181	127.7 ± 17.8	125.6 ± 15.9	0.983	126.6 ± 18.2	125.5 ± 15.8	0.814	126.8 ± 18.6	126.3 ± 17.6	0.495
Diastolic blood pressure (mmHg)	76 ± 10.4	78.8 ± 11.9	0.468	76.2 ± 11.3	78.6 ± 9.8	0.080	78 ± 11.9	76.8 ± 10.2	0.107	76.4 ± 11.3	77.8 ± 10.4	0.840

Mean ± SD; *P* for trend after adjusted for age, gender, education, household income, smoking, physical activity, DM duration, DM treatment, BMI, and energy intake.

J Korean Med Sci 2011; 26: 1201-1208

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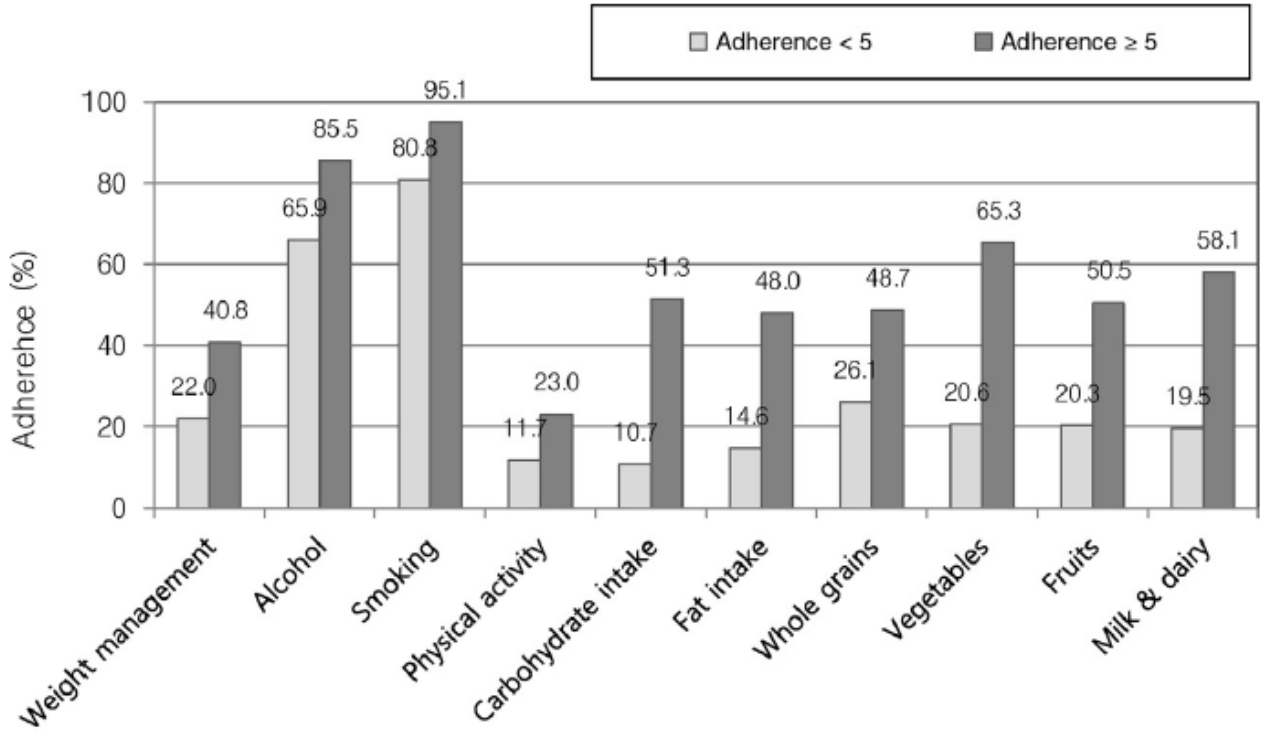
Adherence to lifestyle recommendations is associated with improved glycemic control and improved blood lipid levels in Korean adults with type 2 diabetes



All distributions were significantly different in both groups after adjusted for age, gender, education, income, diabetes duration, and diabetes treatment ($p<0.01$).

Diabetes Res Clin Pract 2013; 101(3): e21-24

Fig. 1 – Percent adherence to each lifestyle recommendation by degree of adherence.

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Implementation of Medical Nutrition Therapy

Table 1 – General and biochemical information according to the degree of adherence to ten lifestyle recommendations in people with known type 2 diabetes.

	Adherence < 5 (*n* = 364) (Mean ± SD)	Adherence ≥ 5 (*n* = 152) (Mean ± SD)	*P*
Age (years)	63.0 ± 10.5	62.0 ± 10.5	NS
Gender (%), male	50.5	37.5	0.0068
DM duration (years)	8.3 ± 8.0	9.0 ± 8.4	NS
DM treatment (%)[a]	80.8	82.2	NS
Body mass index (kg/m^2)	25.3 ± 3.2	24.2 ± 3.1	0.0001
Waist circumference (cm)	88.9 ± 8.6	85.5 ± 8.8	0.0001
Serum triglyceride (mg/dl)[b]	174.0 ± 116.3	149.1 ± 81.8	0.0054
Serum HDL-cholesterol (mg/dl)[b]	43.0 ± 9.5	44.2 ± 10.5	NS
Serum total cholesterol (mg/dl)[b]	192.9 ± 44.3	184.4 ± 38.0	0.0336
Blood glucose (mg/dl)[b]	142.4 ± 48.7	137.6 ± 46.4	NS
Blood insulin (μIU/ml)[b]	11.3 ± 6.7	10.5 ± 5.0	NS
HbA1c (%, mmol/mol)[b]	7.5 ± 1.6	7.2 ± 1.5	0.0112
	58 ± 17	55 ± 16	
HbA1c < 7.0 (%)	46.7	55.9	0.0562

NS, not significant; DM, diabetes mellitus.

[a] DM treatment included oral hypoglycemic agents or insulin.

[b] All blood values were adjusted for age, gender, education, income, diabetes duration, and diabetes treatment.

Subjects who met five or more lifestyle recommendations showed significantly lower blood lipid parameters and glycated hemoglobin than those who did not

Implementation of Medical Nutrition Therapy

개별화된 임상영양요법 실천

- 병력 및 치료계획 점검
- 신체계측자료 평가
- 검사자료/신체증상자료 점검
- 식품영양관련자료 평가
- 영양요구량 결정
- 영양판정 기록

영양판정 | 영양진단

영양사가 독립적으로
치료할 책임이 있는
영양문제를 규명하고
기술하는 것

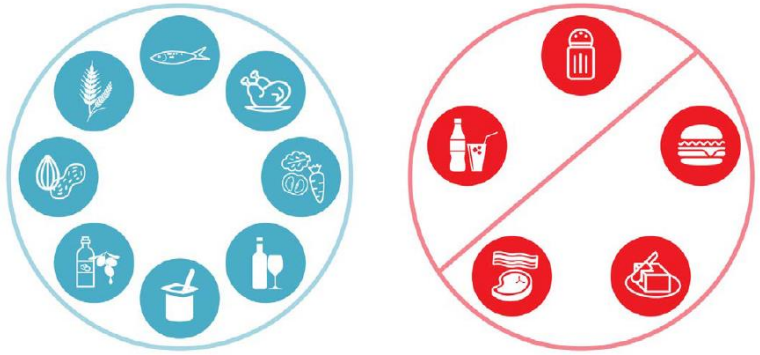
- 섭취영역
- 임상적 영역
- 행동-환경영역

- 당뇨병 관리를 위해 다양한 식사패턴(여러 식품 또는 식품군의 조합)을 허용함
  -개인적인 선호도(전통, 문화, 종교, 건강신념, 경제수준)와 대사조절목표 고려

  ADA, Diabetes Care, 2014;37(suppl 1):S120-42
- 혈당조절 개선을 위해 당뇨병 환자에게 다양한 식사패턴을 사용할 수 있음

  CDA, Can J Diabetes 2013;37:S45-55

Healthy eating pattern



- 전곡류, 가금류, 생선, 채소, 올리브오일, 견과류, 과일, 저지방유제품↑
- 적색육류, 포화지방/트랜스지방, 설탕이 함유된 식품/음료, 나트륨↓

Mediterranean-style(지중해식)

- **Main components**
  - **식물성 식품(과일, 채소**, 빵, 시리얼, 콩, 견과류) 충분히 포함
  - 지역에서 재배된 제철식품을 최소한의 조리/가공하여 섭취
  - 후식은 신선한 과일, 농축된 설탕 또는 꿀은 특별한 경우에만 먹음
  - **음식 속 지방은 주로 올리브오일**
  - 유제품·생선 · 가금류 · 와인은 소량~적당량 정도 섭취
  - **붉은색 고기는 섭취 횟수와 양을 줄임**

➡ **↓혈압, ↓CRP, ↓총 콜레스테롤, ↑HDL콜레스테롤, ↓TG(중성지방), ↓TC:HDL-C(총콜레스테롤과 HDL과의 비율), ↓심장혈관 위험요인**

Implementation of Medical Nutrition Therapy

지중해 식사패턴을 적용한 식단 (1800kcal)

	아 침	점 심	저 녁
곡 류 흰쌀밥 대신에 섬유소가 풍부한 잡곡밥, 통밀빵!	호밀식빵 2장 	콩밥 1공기(210g) 	현미밥 1공기(210g) 
어 육 류 지방이 적은 생선(≥2회/주), 가금류(껍질제외, ≤3회/주)	연어구이 50g 	닭가슴살 80g 샐러드 (허브드레싱) 	허브레몬 삼치 50g구이 
채 소 류 신선하고 향산화 물질이 풍부한 채소반찬 매끼 2~3회!	카프레제 샐러드, 오이피클 	아욱국, 채소샐러드, 브로콜리아몬드볶음 	참나물생채, 쑥갓(두부)무침, 무채국 
간 식 지방이 적은 우유 및 유제품, 항산화 물질이 풍부한 과일 좋은 지방을 함유한 견과류	두유 1잔 	귤 2개, 호상요구르트 1개 	포도 ½송이(19알) 

대한당뇨병학회 Korean Diabetes Association

SNUH 서울대학교병원

Implementation of Medical Nutrition Therapy

식사계획

- **에너지(열량)요구량 및 영양소 구성비율**
  - 근무일은 활동량 고려 **1600kcal**
  - 휴일은 수면시간 길고 활동량 적어 **1400kcal**
  - 당질섭취를 줄이고 균형식 강조
  - 당질 55~60%, 단백질 15~20%, 지방 20~25%

- **식단구성** : 혈당패턴 고려한 식사와 간식 조정
  - 혈당이 높으면 식사와 간식을 줄이거나 섭취시간 조정
  - 바람직한 간식종류와 적정 섭취량 제시
    : 우유 ➡ 저지방유제품 + 견과류(1교환)변경
    : 빵 ➡ 호밀빵/통밀빵/곡물시리얼로 변경, 섭취량 조절

- **염분섭취조절**(권장식품,주의식품,섭취방법 제시)

식사계획

- 고혈압환자가 과체중이나 비만할 경우 체중감량, **DASH 식사패턴**으로 나트륨 줄이고 **칼륨**섭취 늘리기, 알코올 섭취 줄이기, 운동 포함한 생활습관 개선

ADA, Diabetes Care, 38(suppl 1):S20-30

Dietary Approaches to Stop Hypertension (DASH)

Main components

-채소, 과일, 저지방유제품, 전곡류, 가금류, 생선, 견과류 섭취를 늘리고

-포화지방, 적색육류, 설탕이나 설탕이 함유된 음료, 나트륨 섭취를 줄인 식사

➡ ↓혈압, ↓당화혈색소, ↓체중, ↓CRP, ↓LDL콜레스테롤, ↑HDL콜레스테롤

Implementation of Medical Nutrition Therapy

DASH 식사패턴을 적용한 식단 (1600kcal)

	아 침	점 심	저 녁
곡 류 흰쌀밥 대신에 칼륨, 섬유소가 풍부한 잡곡밥, 통밀빵!	콩밥 2/3공기(140g) 	저염 비빔밥(저염비빔밥소스) 잡곡밥 3/4공기(175g) 	현미밥 1공기(210g) 
어 육 류 삼겹살, 갈비 대신에 지방이 적은 가금류(껍질X), 생선, 콩류!	연두부 150g(저염간장 양념) 	소고기 볶음 80g 	고등어 레몬즙 구이 100g 
채 소 류 칼륨과 마그네슘 등이 풍부한 채소반찬 매끼 2~3회!	호박전, 채소피클 	상추, 깻잎, 무생채, 당근채 (비빔밥) 	콩나물냉채, 시금치나물 
간 식 지방이 적은 우유 및 유제품, 칼륨이 풍부한 과일 및 견과류	저지방 우유 1잔 +아몬드 7개 	사과 1/2개 	토마토(소) 2개 

Implementation of Medical Nutrition Therapy

Diabetes Nutrition Therapy: Effectiveness, Macronutrients, Eating Patterns and Weight Management

ABSTRACT

Background: Diabetes nutrition therapy provided for individuals with diabetes must be based on research documenting effectiveness. The roles of differing macronutrient percentages, eating patterns and weight loss interventions are controversial.

Methods: A review of research related to these topics is summarized.

Results: Clinical trials as well as systematic reviews and Cochrane reviews report an approximately 1-2% lowering of hemoglobin $A1_c$ as well as other beneficial outcomes from nutrition therapy interventions, depending on the type and duration of diabetes and level of glycemic control. There are no ideal percentages of macronutrients or eating patterns or both that apply to all persons with diabetes. Clinical trials demonstrate the effectiveness of modest weight loss and physical activity for the prevention or delay of type 2 diabetes. However, as the disease progresses, weight loss interventions may or may not result in beneficial glycemic and other metabolic outcomes.

Conclusions: To be effective, diabetes nutrition therapy must be individualized. Treatment goals, personal preferences (eg, tradition, culture, religion, health beliefs and economics) and the individual's ability and willingness to make lifestyle changes all must be considered when educating or counseling individuals with diabetes. A healthy eating pattern emphasizing nutrient-dense foods in appropriate portion sizes, regular physical activity and support are important. A reduced energy intake for persons with prediabetes or type 2 diabetes and matching insulin to planned carbohydrate intake for insulin users is nutrition therapy interventions shown to be effective in achieving glycemic and other metabolic outcomes.

Key Indexing Terms: Effectiveness of diabetes nutrition therapy; Diabetes macronutrients; Weight loss interventions for diabetes. **[Am J Med Sci 2016;351(4):374–379.]**

Implementation of Medical Nutrition Therapy

Can Macronutrient intake be changed for long term?

- Prescribed diet was **achieved in only 6%** of participants and noted that this "highlights how difficult it is to achieve and maintain prescribed change….. **Individuals trend back to habitual intake over time**
- In the "real world" of diabetes management, it becomes important for health professionals to individualized nutrition-related strategies proven to be beneficial and to facilitate behavior changes that individuals are willing and able to make

- Clinical trials demonstrate the effectiveness of WLIS(modest weight loss and physical activity) for the prevention or delay of type 2 diabetes and improving glycemic control in individuals with newly diagnosed diabetes
- However, **as the disease progresses, weight loss interventions may or may not result in beneficial glycemic and other metabolic outcomes**

Summary

혈당조절을 위한 다량영양소의 이상적 비율에 대한 과학적인 근거 없음

실생활에서 적용가능하고 지속 가능한 개별화된 Eating Pattern 교육 중요

우리나라 식습관을 반영한 Korean Healthy Dietary Pattern 연구 필요

경청해주셔서 감사합니다