Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults: Systematic Review of Evidence for Medical Nutrition Therapy Effectiveness and Recommendations for Integration into the Nutrition Care Process

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THE PREVALENCE OF DIAGnosed diabetes and prediabetes in the United States increases dramatically with each updated report. In 2011-2012, the estimated prevalence of diagnosed diabetes was 12% to 14% among US adults, with a higher prevalence among non-Hispanic black, non-Hispanic Asian, and Hispanic individuals.[1] The prevalence of prediabetes was 37% to 38% in the overall population and, consequently, 49% to 52% of the US population was estimated to have either diabetes or prediabetes. It is encouraging to note that rates of diabetes-related complications have declined substantially in the past 2 decades (depending on the complication, ranging from −67.8% to −28.3%); however, a large burden of the disease persists because of the continued increase in the prevalence of diabetes.[2]

Medical nutrition therapy (MNT) is essential for the optimal management of type 1 and type 2 diabetes in adults. Recommendations and practice guidelines for diabetes medical care from professional organizations acknowledge the importance of nutrition therapy as the foundation for effective comprehensive initial and ongoing diabetes care management.[3-7] The American Diabetes Association states that, "…each person with diabetes be actively engaged in the collaborative development of an individualized eating plan…It is important that each member of the health care team be knowledgeable about nutrition therapy principles for people with all types of diabetes and be supportive of their implementation."[3] To do this, all health professionals involved in diabetes care must have access to evidence for effective diabetes MNT provided by registered dietitian nutritionists (RDNs) and the evidence-based nutrition practice guideline (EBNPG) implemented for nutrition care.[8] To assist in accomplishing these essential goals, this review and a separate review of diabetes nutrition interventions[9] provides a broader audience of RDNs and health professionals with critical evidence and nutrition practice guideline (NPG) recommendations and, importantly, a summary of the Academy of Nutrition and Dietetics (Academy) Evidence Analysis Library (EAL) EBNPG for type 1 and type 2 diabetes in adults.[8]

The Academy has adopted a five-step process to conduct reviews for the EAL and to develop EBNPG for RDNs and other members of health care teams:

- Step 1: Formulate the evidence analysis questions.
- Step 2: Gather and classify evidence (data collection).
- Step 3: Critically appraise each article (risk of bias).
- Step 4: Summarize the evidence.
- Step 5: Write and grade the conclusion statement.[10]

Based on the evidence reviews and the conclusion statements, NPG recommendations are made and integrated into the Nutrition Care Process.

The Academy's EBNPG for type 1 and type 2 diabetes in adults is published in the EAL.[8] Objectives for the EAL review and guideline include to guide decisions that integrate medical, nutrition-based, and behavior strategies; to reduce variations in practice among RDNs; and to develop a guideline for interventions that have measurable clinical outcomes.[8] This review summarizes the evidence for the effectiveness of diabetes MNT provided by RDNs, NPG recommendations, and the integration of the recommendations into the Nutrition Care Process (nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation). The previous review of evidence and EBNPG for adults with diabetes was

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published in the EAL in 2008[11] and published in the *Journal of the American Dietetic Association* in 2010.[12]

REVIEW METHODOLOGY

The Academy's Evidence Based Practice Committee appointed an expert panel to update the 2008 diabetes NPG. The expert committee followed the EAL's rigorous review and guidelines development processes summarized above to develop the guidelines.[10]

Subtopics and Questions

The expert panel identified subtopics and questions that address the major MNT issues for diabetes in adults. A total of 13 subtopics and 19 questions were identified. Five subtopics and five questions related to the effectiveness of MNT provided by RDNs are addressed in this article. Eight subtopics and 14 questions related to nutrition interventions are addressed in another article.[9] The following five primary questions were identified related to the effectiveness of diabetes MNT.

In adults with type 1 and type 2 diabetes:

1. How effective is MNT provided by an RDN on glycemia (glycated hemoglobin [HbA1c] and/or glucose)?
2. How effective is MNT provided by an RDN on cardiovascular disease (CVD) risk factors (lipid levels and/or blood pressure)?
3. How effective is MNT provided by an RDN on weight management (kilograms, waist circumference [WC], and/or body mass index [BMI])?
4. What influence does MNT provided by an RDN have on medication use (insulin and/or other glucose-lowering medications)?
5. What influence does MNT provided by an RDN have on quality of life?

Two secondary questions were also identified: How many encounters with an RDN are needed for the implementation of effective MNT, and What types of MNT interventions implemented by RDNs are effective?

Study Selection

An intensive electronic search was conducted using PubMed and Medline, Cumulative Index of Nursing and Allied Health, Food Science, Sport Discuss, Embase, and the EBSCO Discovery Service databases. The list of titles and abstracts were independently reviewed and titles and abstracts selected that appeared to meet inclusion criteria. The study inclusion criteria included English language; adults aged 18 years or older with type 1 or type 2 diabetes; outpatient and ambulatory care; randomized controlled trials (RCTs), cohort studies, nonrandomized clinical studies, and observational/noncontrolled trials; study duration of at least 12 weeks; 10 or more subjects per study group; and 80% completion rate. In addition to the criteria listed, studies on the effectiveness of MNT must also have documented that MNT is provided by an RDN using an individualized application of the Nutrition Care Process.

Articles were marked for inclusion or exclusion (along with the reason) and any differences were resolved by discussion with a third reviewer. Full texts of articles meeting inclusion criteria were ordered and reviewed and a final list of included articles developed.

Sixty studies met inclusion criteria and were reviewed.[13-73] Twenty-two were related to effectiveness of MNT provided by RDNs[13-35] and 38 studies were related to diabetes nutrition interventions.[36-73] The Figure illustrates the search strategy and study selection process.

Data Extraction and Quality Assessment

Using a standardized online data extraction tool,[10] key data were extracted from each included study: study design, purpose of the study, inclusion and exclusion criteria, country where study was performed, blinding, funding, sample (ie, size, age, ethnicity, and sex), dropout rate, interventions, outcomes measured (HbA1c, glucose values, lipid profile, blood pressure, insulin levels, and weight status), and influence of MNT on medication use and quality of life. From the effectiveness studies, number of RDN encounters, length of time for encounters, and types of nutrition therapy interventions were also extracted. A total of 22 primary studies (18 RCTs, 1 nonrandomized clinical study, and 3 cohort studies, no systematic reviews and no meta-analyses) were analyzed for the effectiveness questions. For the nutrition therapy intervention questions, a total of 38 primary studies (33 RCTs, 4 observational, and 1 systematic review) were analyzed.[9] Risk of bias was assessed for each study using the Academy's quality criteria checklist.[10]

Data Synthesis and Grade

From the summary of evidence, the committee wrote conclusion statements that aggregated the overall evidence presented in the summary tables and answered the research question.[8] Conclusion statements were graded as I (good/strong), II (fair), III (limited/weak), IV (expert opinion only), and V (grade not assignable). From the review and conclusion statements, recommendations were written and rated: strong (quality of evidence is grade I or II), fair (quality of evidence is II or III), weak (quality of evidence is either suspect or well-done studies show little clear advantage to one approach versus another), consensus (expert opinion, grade IV), and insufficient evidence (lack of pertinent evidence, grade V, and/or unclear balance between benefits and harms). Recommendations were also rated as imperative (applies to all members of the specified guidelines population generally) or conditional (applies only under certain circumstances).

EFFECTIVENESS EVIDENCE: MNT IMPLEMENTED BY RDNs FOR TYPE 1 AND TYPE 2 DIABETES IN ADULTS

It is essential that Academy NPGs for any disease/condition be developed based on evidence for the effectiveness of MNT provided by RDNs for that disease/condition. Use of effectiveness evidence facilitates the integration of NPG into the Nutrition Care Process and the successful implementation of the NPG by RDNs. To provide evidence of effectiveness of diabetes MNT provided by RDNs, five primary questions listed in the Review Methodology section were identified. Table 1 summarizes the studies meeting inclusion criteria for effectiveness evidence of MNT reviewed in this article.[13-35] Conclusion statements for the evidence effectiveness of the MNT and nutrition intervention questions are in Table 2. Based on the evidence reviewed and conclusion statements, NPG recommendations for type 1 and

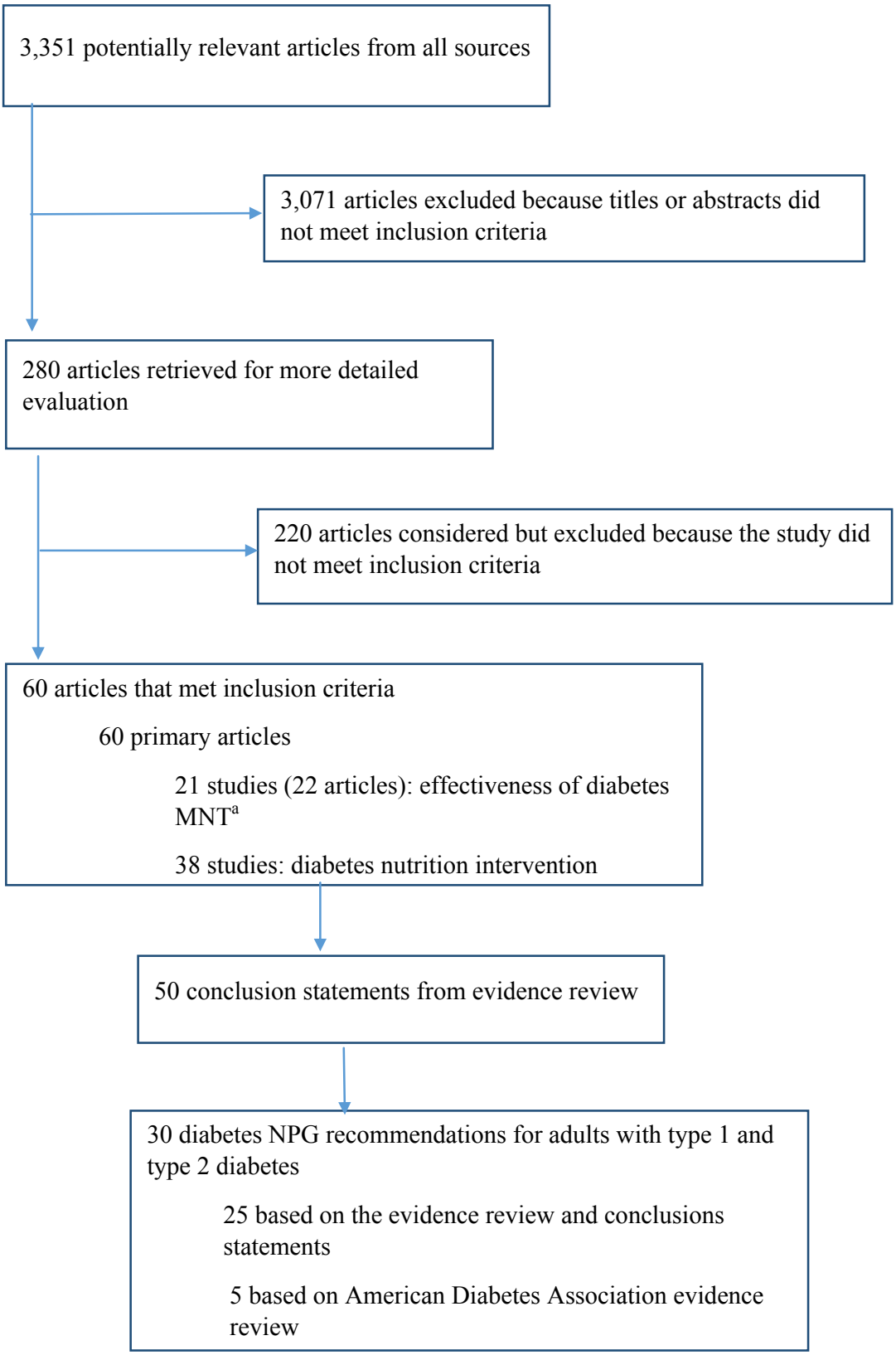

Figure. Flow chart of article selection for the development of diabetes nutrition practice guideline (NPG) recommendations. The literature search resulted in 60 references meeting inclusion criteria, 50 conclusion statements, and 30 NPG recommendations. [a]MNT=medical nutrition therapy.

Table 1. Evidence for effectiveness of medical nutrition therapy (MNT) provided by registered dietitian nutritionists (RDNs) for type 1 diabetes (T1D) and type 2 diabetes (T2D) in adults; the studies summarize the research reviewed in the Academy of Nutrition and Dietetics Practice Guideline for Type 1 and Type 2 Diabetes in Adults to answer the five primary and two secondary questions regarding the effectiveness of diabetes medical nutrition therapy[8]

Study, author(s), y	Population/I[a] duration	I: no. of RDN encounters and length; MNT (type)	Major findings: Glycemia and cardiovascular risk factors	Major findings: Weight, medication changes, quality of life	Study quality
Laitinen and colleagues, 1993[13]	N=86, T2D, newly diagnosed/15 mo	I: 3 initial, 6 follow-up sessions; ↓ calories, individualized, regular eating habits; vs C[b]: follow-up every 2-3 mo for usual education (RCT[c])	HbA1c[d]: At 3-mo baseline 8.4%±2.2% ↓ SS[e] in both groups ($P<0.001$) (as did FG[f]), at 15 mo HbA1c ↓ SS in I vs C (0.6% vs 0.3%); FG ↓ SS in I vs C (25 vs 0 mg/dL[g]) TC[h]: no change NS[i]; HDL-C[j] ↑ SS in I vs C; TG[k] ↓ SS in I vs C	Wt[l]: at 15 mo ↓ SS 5.1 vs 2 .0 kg in I vs C ($P<0.05$)	Positive
UK Prospective Diabetes Study Group, 1990[14] UK Prospective Diabetes Study Group, 2000[15]	N=3,044, T2D, newly diagnosed/3 mo on MNT before randomization	MNT: 3 initial, 6 follow-up sessions; ↓ calories; individualized based on BDA[m] (50-55% CHO[n], 10%-15% protein, 30%-35% fat); at 3-mo randomized to diet alone vs meds (sulphonylurea or insulin) (RCT)	HbA1c: In MNT, at 3-mo baseline 9.0% ↓ to 7.0%; at 12 and 15 mo in MNT vs meds, 7.9% vs 7.0%; FG: in MNT, at 3 mo- ↓ 60 mg/dL Lipids: In MNT, at 3 mo potentially less atherogenic profile	Wt: In MNT, at 3 mo ↓ 4.5 kg	Neutral
The Diabetes Control and Complications Trial Research Group, 1993[16]	N=1,441, T1D/6.5 y	Intensive therapy (insulin pump or MDI[o], monthly visits including RDN) vs conventional therapy (1 or 2 daily insulin injections, clinic visit every 3 mo); monthly; individualized, CHO counting to determine insulin doses (RCT)	HbA1C: I at 6-mo baseline 9.4%±1.2% ↓ to nadir (6.9%) maintained ~6.5 y vs C ($P<0.001$) FG: I, mean value throughout trial 155±30 mg/dL[g] vs C, 231±55 mg/dL[g] ($P<0.001$) LDL-C[p]: I ↓ 34% ($P=0.02$)	Wt: I, 5 y, ↑ 4.6 kg more than in C. Severe hypoglycemia: 3 times higher in I vs C ($P<0.001$) QOL[q]: NS difference between groups despite added demands of I I: SS ↓ risk of microvascular complications	Positive
Franz and colleagues, 1995[17]	N=179, T2D/6 mo	NPG[r] 3 visits, 2.5-3 h; RDN determined nutrition prescriptions and care, ↓ calories vs basic nutrition care of 1 RDN visit (RCT)	HbA1c: ↓ SS in both groups, 0.9% (NPG) and 0.7% (basic) ($P<0.001$); FG: both ↓ SS (20 and 11 mg/dL[g]); HbA1c: in I in newly diagnosed ↓ 1.7% vs 0.4% in longer-duration diabetes TC and TG: NPG SS ↓; LDL-C and HDL-C NS changes	Wt: at 6 mo both SS ↓ (~1.7 kg)	Positive

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Study, author(s), y	Population/I[a] duration	I: no. of RDN encounters and length; MNT (type)	Major findings: Glycemia and cardiovascular risk factors	Major findings: Weight, medication changes, quality of life	Study quality
Dose Adjustment for Normal Eating Study Group, 2002[18]	N=169, T1D/12-mo	Insulin dose adjusted for desired CHO intake at meal vs timing and content of meals based on fixed doses of insulin; visits 4-6 h initially; CHO counting (RCT)	HbA1c: I ↓ SS 9.4%±1.2% to 8.4%±1.2% vs C ↑ 9.3%±1.1% to 9.4±1.3% ($P<0.0001$); 12 mo, remained SS improved (0.5%; $P=0.001$) in I group TC, HDL-C, TG, and BP[s]: NS change.	Wt: NS change Dietary freedom, QOL, treatment satisfaction: I SS improved, maintained to 12 mo ($P<0.0001$), despite ↑ injections (3.6-5.3/d) Hypoglycemia: NS change	Positive
Goldhaber-Fiebert and colleagues, 2003[19]	N=75, T2D/12 wk	I: 11 weekly 90-min nutrition class and triweekly 1-h walking groups; portion control for ↓ kcal vs C: basic diabetes education (RCT)	HbA1c: I vs C, ↓ SS 1.8%±2.3% vs ↓ 0.4%±2.3% ($P=0.028$); FG: I vs C, ↓ 19±55 mg/dL[g] vs ↑ 16±78 mg/dL[g] ($P=0.048$)	Wt: I vs C, ↓ 1.0±2.2 kg vs ↑ 0.4±2.3 kg ($P=0.028$)	Positive
Ash and colleagues, 2003[20]	N=51, T2D/12 wk	3 groups; RDN and physician for 12 wk, follow-up at 18 mo; isocaloric ↓ calories: intermittent ↓ calories vs preportioned meals vs usual (self-selected meals); 12 weekly (RCT)	HbA1C: ↓ SS 1% in all groups ($P<0.001$)	Wt: ↓ SS 6.4 kg in all groups ($P<0.001$). Energy intake: ↓ SS 564±665 kcal/d in all groups ($P<0.001$)	Positive
Lemon and colleagues, 2004[21]	N=244, T2D/6 mo	Nutrition counseling; 3, 2.5 h, additional sessions if needed; ↓ calories, CHO counting, Food Guide Pyramid, exchange lists (cohort)	HbA1c: at 3-mo baseline 8.7%±2.0% ↓ to 7.3%±2.0%, at 6 mo to 7.0%±2.0% (overall=1.7%±2.9%); FG: at 3 mo baseline 200±88 mg/dL[g] ↓to 148±90 mg/dL[g], at 6 mo to 144±83 mg/dL[g] (overall 56±79 mg/dL[g]) (both *P* values <0.0001) TC and TG: at 6 mo SS ↓; LDL-C and HDL-C NS change	Wt: ↓ 6.2±14.6 kg; BMI[t]; ↓ 0.94±2.3 (both *P* values <0.001) QOL: Self-perception of health status improved; felt knowledgeable and motivated after seeing an RDN	Neutral

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Study, author(s), y	Population/I[a] duration	I: no. of RDN encounters and length; MNT (type)	Major findings: Glycemia and cardiovascular risk factors	Major findings: Weight, medication changes, quality of life	Study quality
Takahashi and colleagues, 2004[22]	N=68 elderly, T2D/12 mo	2 groups: new diagnosis or long-term diabetes; simple education, 3 well-balanced meals/d vs 2 groups: new diagnosis or long-term diabetes; conventional education, 3 sessions initially; exchange lists and meal plan (RCT)	HbA1c: At 6 and 12 mo both new diagnosis groups ↓ SS ~1.3%; at 6 and 12 mo both long-term groups ↓ SS ~0.5%. TC, HDL-C, and TG: NS change in all groups	Wt: at 3 mo both new diagnosis groups ↓ SS ($P<0.05$); at 6 and 12 mo NS change	Neutral
Wolf and colleagues, 2004[23]	N=147, T2D/12 mo	I: case management by RDN; 3 initial sessions (6 h), 3 follow-up sessions (6 h); ↓ calories, individualized, ↑ PA[u]) vs C: usual care (RCT)	HbA1c: At 12 mo NS Lipid: All NS change	Wt and WC[v]: At 12 mo NS Diabetes medications: I, at 12 mo ↓ by 0.8/d vs C ($P=0.03$) QOL: I, ↑ vs C ($P<0.05$)	Positive
Barnard and colleagues, 2006[24]	N=99, T2D/6 mo	I: 10 sessions; ↓ calories, low-fat vegan diet vs ↓ calories (RCT)	HbA1c: I vs ↓ calories, ↓ 1.2% vs ↓ 0.4% (both SS); NS between groups FG: I vs ↓ calories, ↓ 49 mg/dL vs ↓ 28; NS between groups TC, LDL-C, HDL-C, and TG: ↓ SS in both groups BP: SS ↓ in both groups	Wt and BMI: ↓ SS in both group; NS between groups	Positive
Barratt and colleagues, 2008[25]	N=53, T2D, initiating insulin therapy/6 mo	I: 6 session, 4 h; ↓ of 500 kcal/d, patient empowerment and support vs C: standard care (RCT)	HbA1c: ↓ SS both groups, I (0.9%; $P<0.05$) and C (1.25%; $P<0.001$) Lipids and BP: NS changes	Wt: I NS vs C ↑ SS (5.2 kg) BMI, and WC: I NS vs C ↑ SS ($P<0.001$)	Positive
Bastiaens, and colleagues 2009[26]	N=44, T2D/18 mo	Team diabetes education in primary care setting; 3 sessions, 6 h; MNT, healthy eating and PA (cohort)	HbA1c: At 12 mo ↓ SS (0.6%), 18 mo ↓ (0.3%) from baseline	Wt, BMI: 12 and 18 mo ↓ SS QOL: Emotional burden of having diabetes ↓ ($P=0.006$)	Positive
Coppell and colleagues, 2010[27]	N=104, long-standing T2D, persistent hyperglycemic, despite 2 meds/6 mo	I: MNT, 7-8 sessions; goal 5% wt loss, individualized healthy eating pattern vs C, no additional MNT (RCT)	HbA1c: I vs C, ↓ 0.8% vs no change (SS) FG: I vs C, ↓ 16 mg/dL[g] vs no change (SS) Lipids and BP: NS changes	Wt, BMI, WC: ↓ SS in I group (2.1 kg) ($P=0.032$)	Positive

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Study, author(s), y	Population/I[a] duration	I: no. of RDN encounters and length; MNT (type)	Major findings: Glycemia and cardiovascular risk factors	Major findings: Weight, medication changes, quality of life	Study quality
Davis and colleagues, 2010[28]	N=165, T2D/12 mo	I: Diabetes TeleCare RDN and nurse; 3 sessions initially, 4 follow-up; ↓ calories vs C: usual care; 1 session, 20 min (RCT)	HbA1c: I vs C, at 12 mo 8.2% vs 8.6% (P=0.004), at 24 mo 7.6% vs 8.1% (P=0.04). LDL-C: I vs C, ↓ SS	Wt, BMI, WC: no SS difference between groups BP: NS difference	Positive
Izquierdo and colleagues, 2010[29]	N=890, T2D Medicare beneficiaries/2 y	Telemedicine (videoconferences with RDN); 1-h initial session, 30-min follow-up every other mo; NPG for MNT vs usual care (primary care) (RCT)	Hb1c, lipids, BP: telemedicine group improved vs usual care group	WC, BMI: telemedicine ↓ SS; associated with ↑ diet and PA knowledge and behaviors	Neutral
Imai and colleagues, 2011[30]	N=101, T2D/24 mo	I: vegetable before CHO at meal vs C: exchange system; 6 sessions first 6 mo, monthly for 2 y; both ↓ calories (RCT)	HbA1c: ↓ SS in both (1.5% [P<0.01] vs 0.9% [P<0.05]); I ↓ SS at 6, 9, 12, and 24 mo vs C (P=0.016) TC, LDL-C: ↓ SS in both (P<0.01); HDL-C, TG: NS	BMI: NS difference within or between groups BP: ↓ SS in I group	Positive
Andrews and colleagues, 2011[31]	N=593, T2D, newly diagnosed/12 mo	I: intense MNT, intense MNT and PA; 6 mo, 3 sessions, 2-3 h, 9 and 12 mo, 1 h; ↓ calories, individualized based on BDA; vs C: standard diet and PA advice (RCT)	HbA1c: both I groups ↓ SS (0.3%), ↑ in C (0.2%) Lipids, BP: NS changes	Wt, WC: Both I groups the same but SS better than C (P<0.0001)	Positive
Laurenzi and colleagues, 2011[32]	N=61, T1D, CSII[w] therapy/24 wk	I: insulin-to-CHO ratios and sensitivity factors; 4-5 individual sessions with RDN and MD; CHO counting vs C: continued as usual estimating premeal insulin (RCT)	HbA1c, FG, daily insulin dose, hypoglycemia: NS change; those in I who continuously used CHO counting and CSII ↓ SS in HbA1c (−0.4%) vs C (−0.05%) (P=0.05)	BMI, WC: I SS ↓ vs C QOL: I vs C, ↑ SS (P=0.004)	Neutral
Al-Shoorkir and colleagues, 2012[33]	N=200, T2D/6 mo	NPG: 3 sessions, 2.5-3 h; ↓ calories; individualized vs C: usual nutrition care (RCT)	HbA1c: NPG ↓ SS (1%; P<0.01) vs NS change in C FG: NPG ↓ SS (22 mg/dL[g]; P<0.01) vs NS change in C TC and TG: NPG ↓ SS; LDL-C and HDL-C: NS	Wt: NPG at 6 mo ↓ SS (5.1 kg; P<0.05) vs NS change in C	Positive

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Study, author(s), y	Population/I[a] duration	I: no. of RDN encounters and length; MNT (type)	Major findings: Glycemia and cardiovascular risk factors	Major findings: Weight, medication changes, quality of life	Study quality
Battista and colleagues, 2012[34]	N=101, T2D and T1D/ 24 mo	I: RDN and endocrinologist; 3 sessions, first 6 mo, 5 follow-up; ↓ calories, healthy eating and PA vs C: endocrinologist alone (RCT)	HbA1c: I ↓ SS 0.6% FG: I ↓ SS 13 mg/dL[g] TC, LDL-C, HDL-C, and TG: NS changes BP: I ↓ vs C ↑	Wt, BMI, WC: I vs C, ↓ SS Wt (−0.7 kg vs +2.1 kg), BMI (−0.3 vs +0.7), WC (−1.3 cm vs +2.4 cm)	Neutral
Barakatun Nisak and colleagues, 2013[35]	N=104, T2D/12 wk	Individualized MNT, ↓ calories; 3 sessions (cohort)	HbA1c: ↓ SS (0.4%; $P<0.001$). FG: ↓ SS 5 mg/dL[g]; $P<0.05$) TC, LDL-C, and TG: NS changes HDL-C: ↑ SS ($P<0.05$)	Wt, BMI: NS changes	Positive

[a]I=intervention group.
[b]C=control group (usual care).
[c]RCT=randomized clinical trial.
[d]HbA1c=glycated hemoglobin.
[e]SS=statistically significant.
[f]FG=fasting glucose.
[g]To convert mg/dL glucose to mmol/L, multiply mg/dL by 0.0555. To convert mmol/L glucose to mg/dL, multiply mmol/L by 18.0. Glucose of 108 mg/dL=6.0 mmol/L.
[h]TC=total cholesterol.
[i]NS=nonsignificant.
[j]HDL-C=high-density lipoprotein cholesterol.
[k]TG=triglycerides.
[l]Wt=weight.
[m]BDA=British Diabetic Association.
[n]CHO=carbohydrate.
[o]MDI=multiple daily injections.
[p]LDL-C=low-density lipoprotein cholesterol.
[q]QOL:quality of life.
[r]NPG=Nutrition Practice Guideline.
[s]BP=blood pressure.
[t]BMI=body mass index.
[u]PA=physical activity.
[v]WC=waist circumference.
[w]CSII=continuous subcutaneous insulin infusion.

Table 2. Systematic evidence review conclusion statements used to develop nutrition practice guideline (NPG) recommendations for the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[8] summarized in Table 3 and to integrate NPG recommendations into the Nutrition Care Process

Nutrition Care Process and subtopics	No. of studies[a]	Conclusion statements from the Evidence Analysis Library	Conclusion statement grade
Nutrition assessment and nutrition monitoring and evaluation			
MNT[b] and glycemia	21[13,14,16-28,30-35]	HbA1c[c]: In T2D[d] MNT decreased HbA1c 0.3% to 2.0% at 3 mo and with ongoing MNT support it was maintained or improved at >12 mo; a variety of interventions implemented, all resulting in a reduced energy intake	I
		HbA1c: In T1D[e] MNT contributed to a decrease of HbA1c of 1.0% to 1.9% at 6 mo, maintained to 1 y and in DCCT[f] for 6.5 y	I
		Glucose: In T1D and T2D FG[g] decreased 18 to 61 mg/dL[h] at 3 mo; with ongoing MNT support it was maintained to 12 mo and in DCCT for 6.5 y	I
MNT and cardiovascular disease risk factors	18[14-27,30,31,33,34]	TC[i]: In T2D (with normal or mildly elevated TC) MNT had mixed effects on TC; in 8 study arms decreases SS[j] from 8 to 28 mg/dL[k]	II
		LDL-C[l]: In T2D (with normal or mildly elevated LDL-C) MNT had mixed effects on LDL-C; in 7 study arms decreases SS from 8 to 22 mg/dL[k]	II
		HDL-C[m]: In T2D (with normal to mildly low HDL-C) MNT had mixed effects on HDL-C; in 3 studies increases SS from 2.4 to 6 mg/dL[k]	II
		TG[n]: in T2D (with normal to elevated TG) MNT had mixed effects on TG; in 7 study arms decreases SS from 15 to 153 mg/dL[o]	II
		BP[p]: in T2D (with near-normal BP) MNT had mixed effects on BP; in 7 study arms decreases SS in SBP[q] and DPB[r] of 3.2 to 9/2.5 to 5.3 mm Hg	II
		TC, HDL-C, TG, BP: in T1D (with near normal lipid and BP) in 2 studies NS[s] changes	II
		LDL-C: in T1D in the DCT at 5-y LDL-C decreased SS	II
MNT and weight management	18[13-16.18-22,24,25,27-31,33,34]	Weight: in T2D mixed outcomes, in 11 study arms decreases SS in weight, 2.4 to 6.2 kg, in 6 study arms weight changes NS; in T1D weight outcomes mixed	II
		BMI[t]: in T2D mixed outcomes, in 9 study arms decreases SS by 0.3 to 2.1, in 8 study arms changes NS; in T1D in 1 study decreases SS of 0.3	II
		WC[u]: in T2D mixed outcomes, in 9 study arms decreases SS of 1.0 to 5.5 cm, in 3 study arms, NS changes; in T1D in 1 study decreases SS of 1 cm	II

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Table 2. Systematic evidence review conclusion statements used to develop nutrition practice guideline (NPG) recommendations for the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[8] summarized in Table 3 and to integrate NPG recommendations into the Nutrition Care Process (*continued*)

Nutrition Care Process and subtopics	No. of studies[a]	Conclusion statements from the Evidence Analysis Library	Conclusion statement grade
Medication use	13[16-19,21,23-27.31-33]	Glucose-lowering medication: in T2D in 12 study arms decreases in doses and/or number of meds; however, due to normal progression of T2D, additional medication eventually needed; initial series of RDN[v] encounters, 3-10 (2-6 h) with continued RDN encounters	I
		Insulin: in T1D in 2 studies number of insulin injections increased, but with MNT HbA1c improved without increase in total insulin dose; series of 4-6 RDN encounters	I
Quality of life	6[14,18,21,23,26,32]	In T2D and T1D, in 6 studies improvements in quality of life SS were reported (improvements such as in self-perception of health status, knowledge and motivation, satisfaction with treatment, psychological well-being); initial series of 3-6 RDN encounters with long-term encounters	I
Nutrition intervention[w]			
Macronutrient composition	7[36-42]	In T1D and T2D, in 3 studies with differing amounts of CHO[x] (39%-57% of kcal/d) NS effects on HbA1c; in 2 studies NS effect on insulin doses and endogenous insulin levels (in adults with well-controlled diabetes) and on TC, LDL-C, and BP	All III
		In T1D and T2D, in 3 studies protein (0.8-2.0 g/d) had mixed effects on HbA1c; no studies reported on insulin levels	III protein; V insulin levels
		In T1D and T2D, in 3 studies with differing amounts of fat (27%-40% kcal/d) effect NS on HbA1c; in 2 studies effect NS on insulin levels, TC, LDL-C, BP; in T1D in 1 study HDL-C and TG changes NS; in T2D in 1 study with higher CHO/lower GI[y]/lower-fat diet decreased HDL-C and increased TG	All III
CHO management strategies	8[14,18,43-48]	In T1D and T2D, on MDI[z] or insulin pump in 8 studies based on CHO counting and using I:C[aa] ratios decreased HbA1C (−1.6% to −0.4%) SS and maintained for up to 44 mo; in 3 studies changes in weight, WC, BMI NS; in T1D in 4 studies improved quality of life SS; majority of studies influence on TC, HDL-C, LDL-C, TG, BP NS; in 3 studies insulin dose varied depending on planned CHO intake but change in total insulin dose NS	I HbA1c and
		No studies identified reporting effectiveness of CHO-counting alone, CHO consistency, plate method, or exchange lists/food lists/CHO choices	II insulin doses, Cardiovascular disease risk factors, and weight, WC, BMI

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Table 2. Systematic evidence review conclusion statements used to develop nutrition practice guideline (NPG) recommendations for the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[8] summarized in Table 3 and to integrate NPG recommendations into the Nutrition Care Process (*continued*)

Nutrition Care Process and subtopics	No. of studies[a]	Conclusion statements from the Evidence Analysis Library	Conclusion statement grade
Fiber (no supplements or fiber-added foods)	2[49,50]	In T1D, in 1 study ~30 g/d fiber had beneficial effect on HbA1c; in T1D and T2D, in 2 studies ~20 g/d fiber had no beneficial effect on HbA1c; in T1D, in 1 study effect (20 g vs 30 g fiber) on insulin doses NS; in T2D, in 1 study ~20 g/d fiber effect on TC, HDL-C, LDL-C was NS	III HbA1c, insulin doses, lipids
		No studies reported effect on BP	
GI	5[40,51-54]	In T2D, in 4 studies effect of GI on Hb1c NS; in 3 studies effect on LDL-C NS, in 2 studies effect on BP NS; in 3 studies mixed effects on TC, HDL-C, TG; in 2 studies mixed effects on endogenous insulin levels	II HbA1c
		In T1D, no studies were identified	III lipid and insulin levels
Nutritive sweeteners such as sucrose and isomaltulose	3[55-57]	In T1D and T2D, in 3 studies consumption as replacement for CHO and in isocaloric diets effect on HbA1c, exogenous or endogenous insulin levels, HDL-C was NS; mixed results on FG, TC, LDL-C, and TG	II HbA1c III insulin levels, lipid levels
Food and Drug Administration–approved NNS[bb]	3[58-60]	In T1D and T2D, in 3 studies NNS (aspartame, stevia, and sucralose) effect on HbA1c and FG NS; in T2D, in 1 study (stevia) effect on endogenous insulin levels, lipid profile, BP was NS	III all
		In T1D and T2D, no studies identified on effects of saccharin, acesulfame K, and neotame on glycemia, lipids, or BP	III
Protein intake and types (vegetable-based vs animal-based) in adults with diabetic kidney disease	5[36-39,61]	In T1D and T2D, in 3 studies mixed effect on HbA1c and FG; in 4 studies protein intake (0.7-2.0 g/d) effect on GFR[cc] NS; no studies on insulin levels	III glycemia, type and GFR I GFR
		In T2D, in 1 study positive influence of soy vs animal protein on proteinuria but not on GFR	V insulin levels

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Table 2. Systematic evidence review conclusion statements used to develop nutrition practice guideline (NPG) recommendations for the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[8] summarized in Table 3 and to integrate NPG recommendations into the Nutrition Care Process (*continued*)

Nutrition Care Process and subtopics	No. of studies[a]	Conclusion statements from the Evidence Analysis Library	Conclusion statement grade
Types of fat (saturated FA[dd] and unsaturated FA)	15[40-42,62-73]	In T1D and T2D, in 6 studies differing amounts effect on HbA1c, FG was NS; in T1D, in 2 studies effect on exogenous insulin doses NS and in T2D in 2 studies effect on endogenous insulin levels was NS; in 6 studies effect on TG and BP was NS and mixed results on HDL-C; in 6 studies decreased saturated FA and increased unsaturated FA mixed effects on TC and LDL-C In T1D and T2D, in 7 of 8 studies n-3 FA effect on HbA1c or FG was NS, in 8 studies effect on insulin levels, TC, HDL-C, LDL-C, and BP was NS and dose-dependent decrease in TG was SS, especially in individuals with hypertriglyceridemia	I differing amounts on glycemia and insulin levels II cardiovascular disease risk factors I n-3 FA on glycemia and cardiovascular disease risk factors II n-3 FA on insulin levels

[a]Study inclusion criteria: humans, adults, English language, subjects with diabetes, 12 wk or longer duration, 10 subjects per study arm, 80% completion rate.
[b]MNT=medical nutrition therapy.
[c]HbA1c=hemoglobin A1c.
[d]T2D=type 2 diabetes.
[e]T1D=type 1 diabetes.
[f]DCCT=Diabetes Control and Complications Trial.
[g]FG=fasting glucose.
[h]To convert mg/dL glucose to mmol/L, multiply mg/dL by 0.0555. To convert mmol/L glucose to mg/dL, multiply mmol/L by 18.0. Glucose of 108 mg/dL=6.0 mmol/L.
[i]TC=total cholesterol.
[j]SS=statistically significant.
[k]To convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.026. To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.6. Cholesterol of 193 mg/dL=5.00 mmol/L.
[l]LDL-C=low-density lipoprotein cholesterol.
[m]HDL-C=high-density lipoprotein cholesterol.
[n]TG=triglycerides.
[o]To convert mg/dL triglycerides to mmol/L, multiply mg/dL by 0.0113. To convert mmol/L triglycerides to mg/dL, multiply mmol/L by 88.6. Triglycerides of 140 mg/dL=1.582 mmol/L.
[p]BP=blood pressure.
[q]SBP=systolic blood pressure.
[r]DBP=diastolic blood pressure.
[s]NS=nonsignificant.
[t]BMI=body mass index.
[u]WC=waist circumference.
[v]RDN=registered dietitian nutritionist.
[w]Study results in nutrition intervention studies are independent of weight loss.
[x]CHO=carbohydrate.
[y]GI= glycemic index.
[z]MDI=multiple daily insulin doses.
[aa]I:C=insulin to carbohydrate ratio.
[bb]NNA=nonnutritive sweeteners.
[cc]GFR=glomerular filtration rate.
[dd]FA=fatty acids.

Table 3. Summary of major nutrition practice guideline (NPG) recommendations from the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[a]

Diabetes NPG recommendation		Rating
Screening and referral		
Screening for T2D[b]	In collaboration with other health care team members ensure that all overweight/obese adults at risk are screened for T2D.	Fair, Imperative
Referral for MNT[c]	In collaboration with other health care team members ensure that all adults with T1D[d] and T2D are referred for MNT.	Strong, Imperative
Initial series of MNT encounters	Implement 3-6 MNT encounters during the first 6 mo, and determine whether additional MNT encounters are needed.	Strong, Imperative
Follow-up MNT encounters	Implement a minimum of 1 annual MNT follow-up encounter.	Strong, Imperative
Nutrition assessment		
Nutrition assessment	Assess the following to formulate the nutrition care plan: biochemical data, medical tests, and medication use; nutrition-focused physical findings; client history; food and nutrition-related history; assess client's psychological and social situation.	Fair, Imperative
Nutrition intervention		
Nutrition prescription	In collaboration with the adult, individualize the nutrition prescription and implement evidence-based nutrition practice nutrition practice guidelines. A variety of eating patterns are acceptable; consider personal preferences and metabolic goals.	Fair, Imperative
Eating plan	For appropriate-weight adult, encourage a healthful eating plan with a goal of weight maintenance and prevention of weight gain.	Consensus, Conditional
	For overweight or obese adult, encourage a reduced energy, healthful eating plan, with a goal of weight loss, weight loss maintenance, and/or prevention of weight gain.	Strong, Conditional
Macronutrient composition	In collaboration with the adult, individualize the macronutrient composition of the healthful eating plan within appropriate energy intake.	Fair, Imperative
Carbohydrate management strategies	For adult taking multiple daily injections of insulin or insulin pump therapy: educate on CHO[e] counting using insulin: CHO based on abilities, preferences, and management goals.	Strong, Conditional
	For adult taking fixed insulin doses or insulin secretagogues, educate on CHO consistency (timing and amount) using CHO counting alone, plate method, portion control, simplified meal plan, or food lists, and CHO choices, based on abilities, preferences, and management goals.	Fair, Conditional
	For adult taking MNT alone or noninsulin secretagogues, educate on CHO management strategies using CHO counting alone, plate method, portion control, simplified meal plan, or food lists and CHO choices, based on abilities, preferences, and management goals.	Fair, Conditional

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Table 3. Summary of major nutrition practice guideline (NPG) recommendations from the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[a] (*continued*)

Diabetes NPG recommendation		Rating
Fiber	Encourage fiber from foods such as fruits, vegetables, whole grains, legumes, as recommended by DRI[f] (21-25 g/d for adult women and 30-38 g/d for adult men) or USDA[g] (14 g/1,000 kcal) due to overall health benefits.	Fair, Imperative
GI[h] and GL[i]	Advise that lowering GI or GL may or may not have a significant effect of glycemic control.	Fair, Conditional
Nutritive sweeteners	Educate that NS[j] when substituted isocalorically for other CHOs, will not have a significant effect on HbA1c[k] or insulin levels.	Fair, Imperative
	Advise against excessive intake of NS to avoid displacing nutrient-dense foods and to avoid excessive caloric and CHO intake.	Fair, Imperative
Nonnutritive sweeteners	Educate that intake of FDA[l]-approved NNS[m] (such as aspartame, sucralose, and stevia) within recommended intake will not have a significant effect on glycemic control	Weak, Imperative
	Educate that substituting foods and beverages containing NNS can reduce overall calorie and CHO intake. However, other sources of calories and/or CHO in these foods and beverages need to be considered.	Fair, Imperative
Protein	Educate that adding protein to meals and snacks does not prevent or assist in the treatment of hypoglycemia. Ingested protein appears to increase insulin response without increasing glucose levels.	Fair, Imperative
	For adult with diabetic kidney disease, advise that a protein restriction is not needed. Protein intake (range=0.7-2.0 g/d) had no significant influence on glomerular filtration rate.	Strong, Conditional
	For adult with diabetic kidney disease, advise that the type of protein (vegetable-based vs animal-based) has no significant effect on glomerular filtration rate.	Weak, Conditional
Cardioprotective eating pattern	Encourage a cardioprotective eating pattern, within the recommended energy intake; decrease in saturated fat intake and increase in unsaturated fat shown to reduce total cholesterol and low-density lipoprotein cholesterol. Nonsignificant effect of differing amounts of saturated fat, unsaturated fat, and n-3 fatty acids on glycemia and insulin levels.	Strong, Imperative
Sodium	Individualized reduction in sodium intake. Recommendation to reduce to <2,300 mg/d is appropriate. In context of hypertension, further reduction in sodium intake should be individualized.	Fair, Imperative
Vitamin, mineral, and herbal supplements[n]	Advise that there is no clear evidence from benefit of supplementation in people who do not have underlying deficiencies; routine supplementation with antioxidants, other micronutrients (such as chromium, magnesium, and vitamin D), and herbal supplements (such as cinnamon) not advised.	Fair, Conditional
Alcohol[n]	When choosing to drink alcohol, advise moderation (1 drink per day or less for adult woman and 2 drinks per day or less for adult men). If using insulin or insulin secretagogues, alcohol can increase risk for delayed hypoglycemia.	Weak, Conditional

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Table 3. Summary of major nutrition practice guideline (NPG) recommendations from the Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults[a] (*continued*)

Diabetes NPG recommendation		Rating
Physical activity[n]	Individualize physical activity plan, advise gradually achieving at least 150 min/wk moderate-intensity aerobic physical activity (50%-70% of maximum heart rate), spread over at least 3 d/wk with no more than 2 consecutive days without exercise.	Strong, Imperative
	For adults using insulin or insulin secretagogoue, educate on prevention and treatment of exercise-related hypoglycemia; use blood glucose monitoring as individual glycemic response patterns can differ markedly with exercise.	Consensus, Conditional
Glucose monitoring[n]	Educate on blood glucose monitoring and using data to adjust therapy.	Consensus, Conditional
Coordination of care	Implement MNT and coordinate care with an interdisciplinary health care team, the adult with diabetes, and important others (eg, family, friends, and colleagues).	Strong, Imperative
Nutrition monitoring and evaluation		
Monitoring and evaluation	Monitor and evaluate the following to determine the effectiveness of MNT: biochemical data, medical tests and medication use; nutrition-focused physical findings; client history; food and nutrition-related history; and monitor and evaluate client's psychological and social situation.	Fair, Imperative

[a]The recommendations were developed based on the systematic evidence review summarized in Table 1 and the conclusion statements summarized in Table 2 and are integrated into the Nutrition Care Process. A description of the ratings is included in the text. All of the recommendations state what the registered dietitian nutritionist should do to provide the best possible nutrition care based on available evidence.[8,77]
[b]T2D=type 2 diabetes.
[c]MNT=medical nutrition therapy.
[d]T1D=type 1 diabetes.
[e]CHO=carbohydrate.
[f]DRI=Dietary Reference Intakes.
[g]USDA=US Department of Agriculture.
[h]GI=glycemic index.
[i]GL=glycemic load.
[j]NS=nutritive sweeteners.
[k]HbA1c=glycated hemoglobin
[l]FDA=Food and Drug Administration.
[m]NNS=nonnutritive sweeteners.
[n]Developed based on evidence reviewed by the American Diabetes Association.[77]

type 2 diabetes in adults were written and integrated into the Nutrition Care Process (Table 3).

QUESTION 1: MNT AND GLYCEMIA

Evidence Reviewed

HbA1c. Outcomes in Type 2 Diabetes. In adults with type 2 diabetes, 21 study arms from 18 studies (n=4,181) (14 RCT,[13-15,17,19,20,22-25,27,28,30,31,33] 1 nonrandomized clinical trial,[34] and 3 cohort studies[21,26,35]) reported that MNT significantly improved HbA1c. At 3 months; 13 study arms from 11 studies[13,14,17,19,20-23,30,33,35] reported decreases from baseline HbA1c levels ranging from 0.3% to 2.0%, at 6 months, 12 study arms from 10 studies[13,17,21,22,24-28,31,33] reported decreases from baseline in HbA1C ranging from 0.3% to 1.8%, and with ongoing MNT support at 12 months, 6 study arms from 4 studies[22,28,30,31] reported continued decreases ranging from 0.3% to 1.6%, and at >12 months, 4 study arms from 3 studies[28,30,34] reported decreases ranging from 0.6% to 1.8%. Although MNT interventions were effective throughout the disease process, the decrease in HbA1c was the largest in studies in which participants were newly diagnosed[13,14,17] and/or had baseline levels >8.0%, in which decreases in HbA1c ranged from 0.5% to 2.0%.[15-19,21,22,24,25,28,30,33]

An initial series of RDN encounters (3 to 11; total encounter time of 2 to 16 hours) with continued RDN encounters throughout the studies were reported. A variety of nutrition therapy interventions, such as individualized nutrition therapy, energy restriction, portion control, sample menus, carbohydrate counting, exchange lists, simple meal plans, and low-fat vegan diet, were implemented and effective. All nutrition interventions resulted in a reduced energy intake.

HbA1c. Outcomes in Type 1 Diabetes. In people with type 1 diabetes, 3 studies (n=808),[16,18,32] reported that MNT contributed to significantly decreased HbA1c levels. At 6 months, 2 studies[16,18] reported that individualized MNT using carbohydrate counting to determine premeal insulin doses assisted in decreasing baseline mean HbA1c levels by 1.0% and 1.9%. An initial series of RDN encounters (4 to 6; total encounter time of 4 to 6 hours) with regular continued RDN encounters were reported. Ongoing MNT support provided by RDNs resulted in maintenance of the reduced HbA1c levels at 1 year,[16,18,32] and in the large Diabetes Control and Complications Trial (DCCT) assisted in maintaining the mean HbA1C level at 6.9% in the intensive treatment arm throughout the 6.5 years of the trial.[16]

Glucose Levels. In adults with type 1 and type 2 diabetes, 8 studies[13,14,17,19,21,24,27,33] reported MNT decreased fasting blood glucose levels at 3 months by 18 to 61 mg/dL (0.999 to 3.386 mmol/L). With ongoing MNT support, decreased levels were maintained for 12 months,[13,14,31,34] and in the DCCT, throughout the 6.5 years of the trial.

Strength of Evidence for MNT and Glycemia: Grade I/Strong

QUESTION 2: MNT AND CVD RISK FACTORS

Evidence Reviewed

Total Cholesterol Outcomes in Type 2 Diabetes. In adults with type 2 diabetes with normal to mildly elevated cholesterol levels, 19 study arms in 16 studies (14 RCT[13,14,17,19,20,22,23-25,27,30,31,33,34] and 2 cohort studies[21,35]) reported that MNT had mixed effects on cholesterol levels. Eight study arms from 6 studies[14,17,21,24,30,33] reported significant decreases in cholesterol ranging from 8 to 28 mg/dL (0.208 to 0.728 mmol/L), and the other study arms reported nonsignificant changes in cholesterol. Approximately 50% to 75% of participants were taking lipid-lowering medications.[19,21,24,31,34,35]

Low-Density Lipoprotein Cholesterol Outcomes in Type 2 Diabetes. In adults with type 2 diabetes and normal to mildly elevated low-density lipoprotein (LDL) cholesterol, 17 study arms in 15 studies (13 RCT[14,17,19,20,23-25,27,28,30,31,33,34] and 2 cohort studies[21,35]) reported that MNT had mixed effects on LDL cholesterol levels. Six study arms from 4 studies[14,24,28,30] reported significant decreases in LDL cholesterol ranging from 8 to 22 mg/dL (0.208 to 0.572 mmol/L), and the other study arms reported nonsignificant changes in LDL levels.

High-Density Lipoprotein Cholesterol Outcomes in Type 2 Diabetes. In adults with type 2 diabetes and normal to mildly low high-density lipoprotein (HDL) cholesterol levels, 19 study arms in 16 studies (14 RCT[13,14,17,19,20,23-28,30,31,33] and 2 cohort studies[21,35]) reported that MNT had mixed effects on HDL cholesterol levels. Three studies[13,20,35] reported significant increases in HDL cholesterol ranging from 2.4 to 6 mg/dL (0.062 to 0.156 mmol/L), and the other studies reported nonsignificant changes in HDL cholesterol.

Triglyceride Outcomes in Type 2 Diabetes. In adults with type 2 diabetes and normal to elevated triglyceride (TG) levels, 19 study arms (14 RCT[13,14,17,19,20,23-25,27,28,30,31,33,34] and 2 cohort studies[21,35]) reported MNT had mixed effects on TG levels. Seven study arms from 6 studies[13,14,17,21,24,33] reported significant decreases in TG ranging from 15 to 153 mg/dL (0.170 to 1.729 mmol/L), and the other study arms reported nonsignificant changes in TG.

Blood Pressure Outcomes in Type 2 Diabetes. In adults with type 2 diabetes and near-normal blood pressure (BP) levels, 12 study arms (8 RCT[19,24,25,27,28,30,31,34] and 2 cohort studies[21,35]) reported that MNT had mixed effects on BP levels. Seven study arms from 6 studies[19,21,24,28,30,34] reported significant decreases in systolic and diastolic BP of 3.2 to 9/2.5 to 5.3 mm Hg. The other study arms reported nonsignificant changes in BP. Approximately 50% to 75% of the study participants were reported to be taking antihypertensive medications.[19,21,24,31,34]

Lipid and BP Outcomes in Type 1 Diabetes. In people with type 1 diabetes and near-normal lipid levels and BP, 2 studies[16,18] reported that MNT led to nonsignificant changes in total cholesterol, HDL cholesterol, and TG and BP. The DCCT at 5 years reported that LDL cholesterol was significantly decreased.[16]

Strength of Evidence for MNT and CVD Risk Factors: Grade II/Fair

QUESTION 3: MNT AND WEIGHT MANAGEMENT

Evidence Reviewed

Weight Management Outcomes. In adults with type 2 diabetes, body weight outcomes from MNT were mixed. At study end, 10 studies reported significantly decreased baseline weight by 2.4 to 6.2 kg,[13,14,17,20,21,23,24,27,31,33] whereas 6 studies reported nonsignificant weight changes at study end.[19,22,25,28,34,35] In persons with type 1 diabetes, weight outcomes were also mixed.[16,18,32,34]

BMI. In adults with type 2 diabetes, BMI outcomes from MNT were also mixed. At study end, 9 studies reported significantly decreases in baseline BMI by 0.3 to 2.1,[14,17,21,24,27,29,31,33,34] whereas 6 studies reported nonsignificant changes in BMI at study end.[19,25,26,28,35,36] In persons with type 1 diabetes, 1 study reported a significant decreased BMI of 0.2 from MNT.[32]

WC. In adults with type 2 diabetes, WC outcomes from MNT were mixed. At study end, 8 studies reported decreases of 1.0 to 5.5 cm,[20,23,24,27,29,31,34,35] whereas, 3 studies reported nonsignificant changes in WC at study end.[25,28,33] In persons with type 1 diabetes, 1 study reported a significantly decreased WC of 1 cm from MNT.[32]

Strength of Evidence for MNT and Weight Management: Grade II/Fair

QUESTION 4: MNT AND MEDICATION USE

Evidence Reviewed

Medication Use Outcomes. In adults with type 2 diabetes, 12 study arms from 11 studies (9 RCT,[15,17,19,23-25,27,31,33] 1 nonrandomized clinical study,[34] and 1 cohort study[21]) reported that MNT resulted in decreases in doses and/or number of glucose-lowering medications used. An initial series of RDN encounters (3 to 10; total encounter time of 2 to 6 hours) with continued RDN encounters throughout the studies were reported. The United Kingdom Prospective Diabetes Study reported significantly improved glucose outcomes from MNT for approximately 2 years. However, due to the normal progression of type 2 diabetes, additional medication(s) were needed to achieve optimal glycemic control. This is not a "diet failure" but instead a failure of beta-cell function. In 1 study, weight gain with initiation of insulin therapy was ameliorated by an intensive MNT intervention.[25]

In 2 studies of adults with type 1 diabetes, RDNs implemented carbohydrate counting for the adjustment of premeal insulin doses.[18,32] In both studies, a series of RDN encounters (4 to 6) were reported. Although the number of insulin injections increased, HbA1c improved without an increase in total insulin doses. In 1 study, weight gain with insulin pump therapy was also prevented.[32]

Strength of Evidence for MNT and Medication Use: Grade I/Strong

QUESTION 5: MNT AND QUALITY OF LIFE

Evidence Reviewed

Quality of Life Outcomes. Improvements in quality of life were reported in adults with type 2 and type 1 diabetes in 6 studies (4 RCTs[16,18,23,32] and 2 cohort studies[21,16]) in which MNT was implemented. In all studies an initial series of 3 to 6 RDN encounters (encounter time of 2.5 to 6 hours) with long-term RDN encounters were reported. In persons with type 1 diabetes, 3 studies[16,18,32] reported significant improvements in quality of life (satisfaction with treatment, psychological well-being) despite increases in number of daily insulin injections and/or MNT requirements. In persons with type 2 diabetes, 3 studies[16,21,23] also reported significant improvements in quality of life (improved self-perception of health status, increased knowledge and motivation, and decreased emotional stress).

Strength of Evidence for MNT and Quality of Life: Grade I/Strong

SECONDARY QUESTIONS: ENCOUNTERS AND MNT INTERVENTIONS

For adults with type 2 diabetes, the initial series of RDN encounters (during initial 3 to 6 months) were a minimum of 3, ranging from 3 to 12 encounters, with a minimum time of 2 hours and ranging from 2 to 16 hours. Follow-up visits (during the next 6 to 15 months) were a minimum of 1, ranging from 1 to 6 encounters with a minimum of 1 hour and ranging from 1 to 6 hours.[8] One 2-year study had monthly visits.[30] For adults with type 1 diabetes, the initial series of RDN encounters (during initial 6 months) ranged from 4 to 6 visits.[8] One long-term study had monthly visits.[16]

For adults with type 2 diabetes, a variety of MNT interventions, such as individualized nutrition therapy, energy restriction, portion control, sample menus, carbohydrate counting, exchange lists, simple meal plans, and low-fat vegan diet, were implemented and effective. All nutrition therapy interventions resulted in a reduced energy intake.[8] For adults with type 1 diabetes, the primary nutrition therapy intervention was carbohydrate counting used to determine mealtime insulin doses.[8]

RESEARCH PUBLISHED AFTER COMPLETION OF THE INITIAL RECOMMENDATIONS

An electronic search similar to the search used for the studies reviewed on effectiveness was conducted. Twenty-one abstracts from April 2013 to May 2016 were reviewed. Nine articles were retrieved for detailed evaluation; 6 studies were excluded because the study did not meet inclusion criteria. Three studies examined the role of MNT provided by RDNs in individuals with type 2 diabetes.[74-76] A cohort study (n=24) of group MNT intervention of obese African-American women with type 2 diabetes reported that 18 weeks after the start of intervention that included a nutrition assessment, nutrition intervention, and outcome assessment, HbA1c decreased by 0.9% (P=0.03), and nonsignificant changes in BMI and BP were reported.[74] In a 6-month RCT (n=61) of urban-dwelling African Americans with type 2 diabetes and hypertension, 18 group sessions by an RDN in a community setting were compared to two 3-hour group sessions taught by a community health worker.[74] HbA1c levels decreased by 0.5% in the RDN group vs an increase of 0.1 (P=0.10) in the other group. Nonsignificant changes in BP and weight were reported.

Persons with type 2 diabetes in two communities in China were randomly assigned to receive RDN-led diabetes nutrition management (n=58) or routine care (n=59).[76] Persons in the RDN-led group over a 3-month period received MNT in a 6-hour basic

nutrition program with 1 training session, followed by another 3 sessions to develop skills and behaviors, and 3 individualized nutrition counseling sessions, whereas the control group received routine care practiced in community health centers. The primary outcome of HbA1c improved significantly at 1 year compared with the control groups (HbA1c: −0.5% vs −0.0%; P=0.000). Total cholesterol and TG levels also improved significantly relative to control (P=0.039 and P=0.016, respectively) and nonsignificant improvements in BP and weight were reported.

These studies support the effectiveness of MNT provided by RDNs using the nutrition care process on glucose and lipid outcomes and the mixed outcomes on weight measures.

Limitations of Current Research and Additional Research Needed

In the MNT and CVD risk factors review, subjects did not have or were not described as having any disorders of lipid metabolism or hypertension. Furthermore, the effectiveness of MNT may have been confounded by lipid-lowering or antihypertensive medications. Additional long-term studies are needed to ascertain the effectiveness of MNT on lipid profiles and BP in adults with diabetes and disorders of lipid metabolism and hypertension. It is important that additional research on all areas of effectiveness of MNT provided by RDNs continue to be published.

INTEGRATING NPG RECOMMENDATIONS INTO THE NUTRITION CARE PROCESS

Based on the effectiveness research reviewed, the following are the recommendations for the Academy's EBNG for type 1 and type 2 diabetes in adults Nutrition Care Process screening and referral, assessment, intervention, and nutrition monitoring and evaluation sections. Also reviewed was evidence from the American Diabetes Association systematic review and recommendations.[77]

SCREENING AND REFERRAL NPG RECOMMENDATIONS

Screening for Type 2 Diabetes

RDNs, in collaboration with other members of the health care team, should ensure that all overweight or obese adults at risk are screened for type 2 diabetes. Screening to assess risk for future diabetes in asymptomatic people should be considered in adults of any age who are overweight or obese (BMI 25 or more [23 more in Asian Americans]) and who have one or more additional risk factors for diabetes. **Rating: Fair, Imperative**

Referral for MNT

RDNs, in collaboration with other members of the health care team, should ensure that all adults with type 1 diabetes and type 2 diabetes are referred for MNT. Individuals who have diabetes should receive individualized MNT to facilitate achievement of treatment goals, preferably provided by an RDN familiar with the components of diabetes MNT. **Rating: Strong, Imperative**

Initial Series of MNT Encounters

RDNs should implement 3 to 6 MNT encounters during the first 6 months, and based on an individualized assessment, determine whether additional MNT encounters are needed. In studies reporting on the implementation of an initial series of RDN encounters (3 to 11; total of 2 to 16 hours), MNT significantly lowered HbA1c by 0.3% to 2.0% in adults with type 2 diabetes and by 1.0% and 1.9% in adults with type 1 diabetes during the first 6 months, as well as optimized medication therapy and improved quality of life. **Rating: Strong, Imperative**

MNT Follow-Up Encounters

RDNs should implement a minimum of 1 annual MNT follow-up encounter. Studies longer than 6 months report that continued MNT encounters resulted in maintenance and continued reductions of HbA1c for up to 2 years in adults with type 2 diabetes, and for up to 6.5 years in adults with type 1 diabetes. **Rating: Strong, Imperative**

NUTRITION ASSESSMENT NPG RECOMMENDATIONS

RDNs should assess the following in adults with type 1 diabetes and type 2 diabetes to formulate the nutrition care plan:

- *Biochemical data, medical tests, and medication use:* type of diabetes, glycemic control, lipid profiles, BP, state of chronic kidney disease, use of glucose- and lipid-lowering medications, prescription and other over-the-counter medications, herbal supplements, and complementary or alternative medications.
- *Nutrition-focused physical findings:* height, weight, BMI and WC, injection sites, relative importance of weight management.
- *Client history:* general heath and demographic information; social history, cultural preferences; health literacy and numeracy; education and occupation; knowledge, beliefs, attitudes, motivation, readiness to change, self-efficacy and willingness and ability to make behavior changes; physical activity; patient or family nutrition-related medical and health history; other medical or surgical treatments; and previous nutrition care service and MNT recommendations.
- *Food and nutrition-related history:* food beverage and nutrient intake, including energy intake; portion sizes; meal-snack spacing and patterns; carbohydrate, fiber, types and amounts of fat, protein, micronutrient intake; and alcohol intake.
- Experience with food, previous and current food and nutrition history, eating environment, access to healthy foods, and eating out.

Assessment of a patient's psychological and social situation should be included as an ongoing part of the medical management of diabetes, which may include, but is not limited to, attitudes about the illness, expectations for medical management and outcomes, affect and mood, general and diabetes-related quality of life, resources (financial, social, and emotional), psychiatric history, as well as addressing common comorbid conditions that may complicate diabetes management. **Rating: Fair, Imperative**

NUTRITION INTERVENTION NPG RECOMMENDATIONS

RDNs should individualize the nutrition prescription and implement evidence-based guidelines in collaboration with the adult with diabetes.

A variety of eating patterns are acceptable for the management of diabetes. Personal preferences (eg, tradition, culture, religion, health beliefs, goals, and economics) should be considered when recommending one eating pattern over another. Treatment decisions should be founded on evidence-based guidelines that are tailored to individual patient preferences. **Rating: Fair, Imperative.**

Other nutrition intervention recommendation based on evidence reviewed, conclusion statements, and NPG recommendations are summarized in Table 3.[9,77]

NUTRITION MONITORING AND EVALUATION NPG RECOMMENDATIONS

Monitor and Evaluate the Effectiveness of MNT

RDNs should monitor and evaluate the factors listed above in Nutrition Assessment, including the patient's psychological and social situation. **Rating: Fair; Imperative**

CONCLUSIONS

The systematic review for the Academy's Nutrition Practice Guideline for Diabetes Type 1 and Type 2 in Adults reviewed 13 subtopics with 19 questions. Summarized are 5 subtopics and 5 questions related to effectiveness of MNT provided by RDNs on glycemia, CVD risk factors, weight management, and the influence of MNT on diabetes-related medications and quality of life. Table 2 summarizes the subtopics and the number of studies reviewed, conclusion statements, and grade for each subtopic of the diabetes NPG. Table 3 summarizes the major NPG recommendations developed from the evidence reviewed in Tables 1 and 2.

Strong evidence supports the effectiveness of MNT provided by RDNs on HbA1c with decreases up to 2.0% at 3 months, and with ongoing MNT support, decreases were maintained or improved long-term. Evidence is mixed for the effectiveness of MNT on CVD risk factors, likely confounded by normal to mildly abnormal lipid levels or near-normal hypertension levels and use of lipid-lowering or antihypertensive medications. Weight management outcomes were also mixed. Strong evidence also supported the positive influence of MNT on medication use and quality of life.

Based on the evidence, NPG recommendations were integrated into the Nutrition Care Process (nutrition assessment, nutrition intervention, and nutrition monitoring and evaluation). Answers to the secondary questions also emerged from the systematic review of effectiveness of MNT provided by RDNs and highlighted the importance of a number of initial encounters (minimum of 3) for assessment, intervention, and evaluation, and follow-up encounters for continued education and support. Therefore, it is recommended that RDNs implement 3 to 6 encounters during the first 6 months then determine whether additional encounters are needed. A minimum of one annual MNT follow-up encounter is also recommended.

Individualized MNT implemented in collaboration with the individual with diabetes is essential because a variety of nutrition interventions are effective. A common focus of MNT for individuals with type 2 diabetes is reduced energy intake and for individuals with type 1 diabetes a common focus is on use of carbohydrate counting to determine premeal insulin boluses. Successful diabetes management requires RDNs to be active members of health care teams who provide evidence-based, effective MNT.

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