REVIEW

Planning Nutritionally Adequate Diets for Groups: Methods Used to Develop Recommendations for a Child and Adult Care Food Program

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ABSTRACT

Planning nutritionally adequate intakes for large groups of people presents many challenges. Because of between-person variations in both food choices and nutrient requirements, it is necessary to examine nutrient intake distributions and select a Target Median Intake (TMI) that will lead to a low prevalence of inadequate nutrient intakes. The TMI may then be used to guide a feeding or education program. A comprehensive report from the Institute of Medicine evaluated nutrient intakes from the NHANES and recommended new meal patterns for all age groups (other than infants) served by the Child and Adult Day Care Food Program, which provides meals and snacks to children and adults in a variety of care settings. The Estimated Average Requirement, a DRI value, for each nutrient of interest was used to estimate both the prevalence of inadequate intakes as well as the changes in the intake distribution that are needed to reduce unacceptably high levels of inadequacy. For nutrients with an Adequate Intake (AI), the prevalence of inadequacy could not be estimated, but the AI could be used as the TMI. Simultaneously, it was important to ensure that the new intake distributions did not result in intakes that exceeded the Tolerable Upper Intake Level for any nutrient. Data for 2- to 4-y-old children are presented in detail to illustrate this process. Of 18 nutrients examined, analyses showed that intakes of vitamin E, potassium, and fiber should be increased, while intakes of sodium should be decreased. If more recent nutrient standards are used, revised assessments show that calcium intake should also be increased, while potassium intake is adequate. These methods and results should be useful when designing feeding programs for other population groups within the United States, as well as in other countries. *Adv Nutr* 2021;12:452–460.

Keywords: nutrient intake, Target Median Intake, Dietary Reference Intakes, nutrient adequacy, feeding programs, Child and Adult Care Food Program

Introduction

Planning nutritionally adequate meals and snacks for large groups presents challenges that are not generally encountered with planning diets for individuals. For instance, because of between-person variations in both food choices and nutrient requirements, it is difficult to design feeding programs for large groups that have a low prevalence of inadequate nutrient intakes. The DRIs are nutrient standards for the United States and Canada (1). They may be used to estimate the current prevalence of inadequate nutrient intakes within a population, as well as to determine if changes in intakes are needed (2). As shown in **Figure 1**, if intakes need to be modified, a more desirable intake distribution can be determined, such that the prevalence of inadequacy is reduced. The median of the new distribution is the Target Median Intake (TMI), which then may be used to design a feeding program (3). The TMI is calculated based on the amount that an intake distribution curve needs to shift in order to yield a low prevalence of inadequacy for the population. It is important to recognize that neither the Estimated Average Requirement (EAR) nor the RDA should be used as the TMI for a group. As noted in a theoretical example in the Institute of Medicine's (IOM's) report, "Dietary Reference Intakes, Applications in Dietary

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Abbreviations used: AI, Adequate Intake; CACFP, Child and Adult Care Food Program; CDRR, Chronic Disease Risk Reduction Intake; DGA, Dietary Guidelines for Americans; DGV, dark-green vegetable; EAR, Estimated Average Requirement; IOM, Institute of Medicine; oz, ounce; TMI, Target Median Intake; UL, Tolerable Upper Intake Level.

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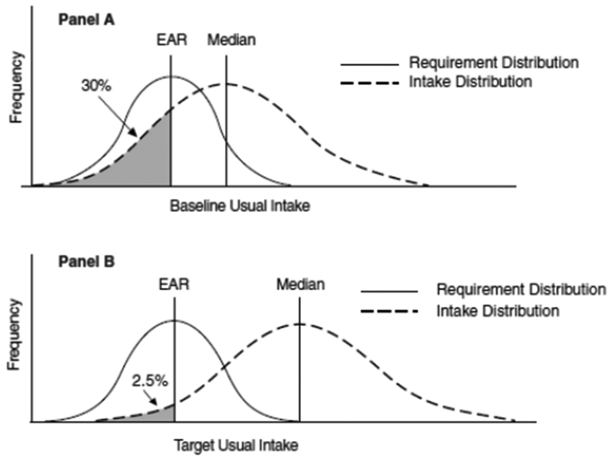

FIGURE 1 Concept of a target usual intake distribution. Panel A shows the baseline usual nutrient intake distribution, in which the prevalence of inadequate intake (percentage below the EAR) is ∼30%. Shifting the baseline distribution up so that the prevalence of inadequate intakes reflects the planning goal (in this example, 2–3%) attains the target usual nutrient intake distribution (B). EAR, Estimated Average Requirement. Reproduced from reference 3 with permission.

Planning" (3), using the RDA as the target would result in a prevalence of inadequacy of ∼30%, while using the EAR at the target would result in a prevalence of 50%; only a TMI calculated by shifting the current intake distribution curve would yield a low inadequacy prevalence.

Any changes in nutrient intakes that are needed may then be used to design menus that are economical, practical, and acceptable to the group. Practical considerations related to purchasing, preparing, and serving meals and snacks for a large group, as well as the costs incurred, can limit the ability of a program to meet the group's needs. We applied these concepts to the design of the food program delivered through the USDA's Child and Adult Care Food Program (CACFP) (4).

CACFP is a nutrition-assistance program that reimburses providers of meals and snacks for children and adults in daycare settings. In 2009, at the time of the IOM study, the program served >3 million infants and children and ∼114,000 adult low-income participants in family daycare homes, traditional child care centers, at-risk afterschool and outside school care facilities, adult care facilities, and emergency shelters. CACFP providers typically serve either a meal and 2 snacks (e.g., morning snack, lunch, afternoon snack) or a snack and 2 meals (e.g., breakfast, morning snack, lunch). Because CACFP standards help ensure the nutritional quality and safety of the meals and snacks that are served, the program not only contributes to healthy food intake but also exemplifies healthy food patterns that can be applied to eating occasions in other settings such as in the home.

In 2010, the Food and Nutrition Service of USDA asked the IOM's Food and Nutrition Board to convene a consensus committee to review the CACFP program and recommend ways to improve its meal requirements. These recommendations were presented in a 2011 IOM report, "Child and Adult Care Food Program, Aligning Dietary Guidance for All" (4). An important step in determining the needed revisions was to determine appropriate nutrient targets for the age groups served. To accomplish this task, the committee followed the recommendations from the IOM report, "Dietary Reference Intakes: Applications in Dietary Planning" (3), on using the DRIs to plan intakes for groups and to set TMIs for each age group within the target population.

Below we summarize each step of the process and illustrate how it was applied to determining nutrient intakes for CACFP participant groups. A similar process was previously used to recommend revisions to the school lunch and school breakfast programs in the United States (5), but these food programs apply only to school-age children. Thus, we chose to use the CACFP to illustrate the TMI process because this program cuts across many different settings and participants encompass all age groups. Therefore, the methodology should be applicable to a wide variety of feeding programs.

Current Status of Knowledge

Planning diets for large groups is a multistep process, beginning with decisions about program goals. Typically, this includes providing meals and snacks that will ensure a low prevalence of nutrient inadequacy, ideally <5% of participants. Thus, the steps include the selection of nutrient standards to use to evaluate intakes, applying these standards to current intakes to determine what changes are needed, and then deciding how to achieve these changes through food-based interventions. An application of this process to the US school meals program has been described in an IOM report from 2009 (5), and then was extended to all age and sex groups in 2011 to be applicable to the CACFP (4). The TMI process has also been previously described in theoretical terms, and with hypothetical examples (6–8), but this is the first time, to our knowledge, that the TMI approach has been used to set nutrient targets for a large feeding program that covers all age groups.

Using DRIs as nutrient standards to plan nutrient intakes of groups

The DRIs for the United States and Canada underpin all of the USDA's food programs, and as such, are the appropriate nutrient standards to evaluate nutrient intakes of CACFP participants (1). A particularly useful DRI for group applications is the EAR. For most nutrients, the prevalence of nutrient inadequacy within a group can be estimated as the percentage of individuals within the group with usual long-term intakes below the EAR (2). Using this information, changes in nutrient intakes that are needed to reduce the prevalence of inadequacy to an acceptable level (typically, 2.5–5%) can be determined.

Nutrients for which an EAR cannot be established have an Adequate Intake (AI). For groups, an AI may be considered

TABLE 1 Description of age categories for CACFP nutrient targets[1]

Age range,[2] y	Body weight,[3] kg	Recommended calorie level,[4] kcal/d	Corresponding USDA food pattern, kcal/d	Physical activity level	Meal distribution, % BLDS
1	11.6	950	1000	Low-active	20, 26, 26, 28
2–4	16.1	1300	Average of 1200 and 1400	Low-active	20, 26, 26, 28
5–10	30.9	1800	1800	Active	22, 32, 32, 14
11–13	54.0	2000	2000	Low-active	22, 32, 32, 14
14–18	63–73	2400	2400	Low-active	22, 32, 32, 14
19–59	75–88	2200–2400	2200	Sedentary	22, 32, 32, 14
≥60	73–87	1900	2000	Sedentary	22, 32, 32, 14

[1]CACFP, Child and Adult Care Food Program; % BLDS, percentage of calories at breakfast, lunch, dinner, snacks.
[2]Age in years is inclusive of the full year at the top of the range: for example, 2–4 y includes ages 2.0 through 4.9 y.
[3]Body weight was based on previously published data for children (5, 10); for adults, body weight was calculated from measured heights (11) and an assumed BMI (kg/m^2) of 22 for adults aged 19–59 y and a BMI of 25 for adults ≥60 y.
[4]Recommended calorie levels rounded to nearest 50 kcal/d for children age 1 y and to nearest 100 kcal/d for all others; average for males and females.

the desirable median intake, since it is thought to be the median intake of healthy populations. In this case, a low prevalence of inadequacy is assumed if a group's median intake is at or above the AI. It should be noted that, if an AI is not based on the median intake of a healthy population, then the confidence in this assumption is reduced.

Another DRI that is useful when planning intakes for groups is the Tolerable Upper Intake Level (UL), which identifies usual intakes that may increase the risk of adverse health effects. For groups, the goal is to ensure that the prevalence of intakes above the UL is as low as possible, typically, not greater than 3–5%. Thus, the key to planning nutrient intakes using the DRIs is to aim for a distribution of intakes, such that there is a low prevalence of usual intakes that are either inadequate or excessive.

Sodium is an exception to this approach because intakes are typically excessive and should be reduced. Although an AI has been set for sodium, most intakes are well above both the AI and the UL. Thus, for practical reasons, the planning goal was to reduce the median intake to the UL, and not to the AI. A new DRI for sodium has been set, the Chronic Disease Risk Reduction Intake (CDRR), which now serves as a goal for reducing excess sodium intakes (9). Thus, at present, there is no UL for sodium.

Selecting age categories, physical activity levels, and energy requirements

Early in the process, age and sex categories of the populations served by the program should be determined. This choice guides the selection of nutrient targets and, ultimately, of the foods that would be served to meet these targets. Because it is seldom practical to provide different foods for males and females of the same ages, the requirements for these 2 groups may be combined, meeting the nutrient needs of both sexes. If the requirements are substantially different, it may be desirable to use a nutrient density approach (4). Likewise, for practical reasons, DRI age groups may need to be combined so that children within a setting, such as a daycare setting, are given similar meals and snacks. To simplify food preparation and service, as well as ease of monitoring compliance, CACFP meal patterns were initially specified for 5 child and 2 adult age groups (**Table 1**). Although guidelines were set for infants <1 y of age (4), they were more general than those for older children, and thus are not covered here.

For each age group, a recommended calorie intake was determined based on DRI calculations (10) using body weights and an assumed activity level. Body weights were based on median weights for children up to age 5 y used in the DRI report on energy requirements (10) and on body weights used for the IOM school meals report for children ages 5 through 18 y (5). For adults, body weights were calculated from heights in the NHANES 2003–2004 (11), assuming a BMI (in kg/m^2) of 22 for adults 19 to 59 y of age and a BMI of 25 for adults aged ≥60 y. These data were then used in the DRI equations to calculate daily energy requirements (Table 1). In order to determine calorie distribution across meals and snacks, typical distributions of calories at meals were examined as a percentage of total daily energy intake using the NHANES data (11). By design, calorie levels for lunch and supper were the same, to simplify menu design and food preparation. Remaining calories were allocated to snacks (Table 1).

Assembling data on current intake distributions

As noted above, the goal of CACFP is to provide meals and snacks that, if consumed, will result in a low (<5%) prevalence of nutrient inadequacy. Setting nutrient targets that fulfill this goal requires examining intake distributions as well as mean intakes. The first step is to determine current nutrient intake distributions, and then to decide how the distribution should be changed to give a low prevalence of inadequacy (as shown in Figure 1). For CACFP, nutrient intake data from NHANES 2003–2004 were used. Intakes from dietary supplements were not included in the analyses because the goal was to set nutrient targets for food intake, without depending on supplements to fill gaps (4).

TABLE 2 DRIs, daily intakes, and prevalence of inadequacy for children 2–4 y of age in NHANES 2003–2004[1]

	EAR/AI[2]	UL[2]	Median intake[3,4]	Intake at fifth percentile	Intake at 95th percentile	Prevalence of inadequacy,[5] %
Nutrients with an EAR						
Protein, g/kg	0.83	NS	3.55	1.90	5.89	0
Vitamin A, μg RAE	232	600	500	269	878	1.8
Vitamin C, mg	16.0	400	89.3	29.8	207	1.2
Vitamin E, mg αT	5.3	200	3.9	2.1	6.8	82
Thiamin, mg	0.4	NS	1.26	0.79	1.97	0
Riboflavin, mg	0.4	NS	2.03	1.25	3.13	0
Niacin, mg	5.3	10.0	14.6	8.17	24.4	0.2
Vitamin B-6, mg	0.4	30.0	1.37	0.82	2.41	0
Folate, μg DFE	133	300	397	214	735	0.1
Vitamin B-12, μg	0.8	NS	4.46	2.48	8.69	0
Phosphorus, mg	388	3000	1084	693	1623	0.1
Magnesium, mg	80	65	191	122	286	0.2
Iron, mg	3.4	40.0	11.4	6.26	19.4	0.7
Zinc, mg	3.0	7.0	8.5	5.23	13.7	0.1
Nutrients with an AI						
Calcium,[6] mg	600	2500	966	519	1591	Assumed low
Fiber, g	21	NS	9.8	4.9	16.2	Unknown
Potassium,[6] mg	3267	NS	2114	1320	3249	Unknown
Sodium,[6] mg	1067	1633	2212	1232	3629	Assumed low

[1] AI, Adequate Intake; DRR, Chronic Disease Risk Reduction Intake; DFE, dietary folate equivalents; EAR, Estimated Average Requirement; NS, no UL was set for these nutrients; RAE, retinol activity equivalents; UL, Tolerable Upper Intake Level; αT, α-tocopherol.

[2] EARs and AIs are weighted averages across 2 DRI age groups (1–3 y and 4–8 y); UL is the lower of the ULs for the 2 DRI age groups (1); ULs for some nutrients refer to different forms of the nutrient than the form used for the EAR/AI (vitamin A, magnesium, niacin, and folate).

[3] Intake data from NHANES 2003–2004 (11).

[4] Intake from supplements is not included.

[5] Prevalence of inadequacy based on usual intakes using PC-SIDE (12).

[6] New DRIs have recently been set for calcium (EAR = 600 mg/d), sodium (AI = 867 mg/d, CDRR = 1300 mg/d), and potassium (AI = 2100 mg/d) (9, 15). Using these revised values, calcium inadequacy would be >5% while potassium inadequacy could be assumed to be low.

Because few differences in intakes were observed across income categories, data were not limited to low-income persons, even though CACFP targets low-income populations. The larger sample size for each age group adds reliability to the intake distribution estimates, particularly for intakes in the upper and lower distribution tails.

Two days of intake were collected using 24-h recall methodology (11). Usual intake distributions, adjusted for day-to-day variation in intakes, were calculated using PC-SIDE software from Iowa State University (12). The prevalence of inadequacy was then determined as the proportion of the population with usual intakes below the EAR, using the EAR cutoff approach (13). Protein requirements were calculated for each participant based on body weight. Because iron requirements are not symmetrically distributed (14), the full probability approach was used to assess intakes (2). For nutrients with an AI, the prevalence of inadequacy cannot be calculated, but if the mean intake is above the AI, inadequacy is typically assumed to be low. As noted in the IOM report (4), vitamin D intake was not evaluated because there is a lack of reliable data on the content in foods and also on intakes of this vitamin. A further consideration was that vitamin D sources are highly variable and not under the control of CACFP providers.

To illustrate further details of the process for planning intakes for CACFP participants, results for children ages 2–4 y are presented here. We chose this age group to illustrate the process because preschool children in care homes and centers are the largest category of CACFP participants other than infants (4). Similar information for all CACFP age groups is given in the IOM report (4). **Table 2** shows the DRI values that were used in the analyses: EAR, AI, and UL. These DRIs are weighted averages, because the DRI age groups for young children (1–3 and 4–8 y) do not match the 2- to 4-y-old age group used for the CACFP. Two-thirds of the average comes from the DRIs for 1- to 3-y-olds (2- to 3-y-olds in CACFP) and one-third from the DRIs for 4- to 8-y-olds (4-y-olds in CACFP). However, the prevalence of intakes below the EAR was calculated using an algorithm that examines the ratio of intake to the age-appropriate EAR for each child. To be conservative about the possibility of adverse effects from excessive intakes, the lower of the 2 ULs was used, rather than a weighted average.

Nutrient intakes (median, 5th percentile, and 95th percentile) for children ages 2–4.9 y in NHANES 2003–2004 (375 males and 388 females) are shown in Table 2, as well as the prevalence of inadequacy. For nutrients with an EAR, the prevalence of inadequacy is low (<5%) for all nutrients evaluated except for vitamin E (where the prevalence of inadequacy equals 82%). For nutrients with an AI, median calcium and sodium intakes were above the AI, implying a low prevalence of inadequacy. Median fiber and potassium intakes were considerably below the AI.

TABLE 3 Change in daily intakes needed to achieve a low prevalence of inadequacy, TMIs, nutrients/day in a 1300-kcal/d USDA food pattern and projected 95th percentile of intake/day for children 2–4 y of age[1]

	Change so fifth percentile = EAR[2]	TMI[3]	Change so median = AI	TMI = AI	Nutrients in USDA food pattern[4]	Projected 95th percentile of intake	Projected 95th percentile as % of UL
Nutrients with an EAR							
Protein,[5] g/kg	−1.07	40	—	—	59	NA	NA
Vitamin A, μg RAE	−38	462	—	—	639	840	140
Vitamin C, mg	−13.8	76	—	—	96	194	48
Vitamin E, mg αT	+3.2	7.1	—	—	5.9	9.9	5
Thiamin, mg	−0.36	0.90	—	—	1.4	NA	NA
Riboflavin, mg	−0.82	1.21	—	—	1.9	NA	NA
Niacin, mg	−2.83	11.8	—	—	15.0	21.5	215
Vitamin B-6, mg	−0.39	0.98	—	—	1.6	2.0	7
Folate, μg DFE	−81	316	—	—	445	655	218
Vitamin, B-12, μg	−1.68	2.8	—	—	5.5	NA	NA
Phosphorus, mg	−305	836	—	—	1142	1375	46
Magnesium, mg	−42	148	—	—	244	243	375
Iron, mg	−2.86	8.5	—	—	11.6	16.5	41
Zinc, mg	−2.33	6.3	—	—	9.4	11.5	164
Nutrients with an AI							
Calcium,[6] mg	—	—	−366	600	866	1225	49
Fiber, g	—	—	+11.2	21.0	19.5	NA	NA
Potassium,[7] mg	—	—	+1153	3267	2568	NA	NA
Sodium,[8] mg	—	—	−579	1633	1227	3050	203

[1] AI, Adequate Intake; DFE, dietary folate equivalents; CDRR, Chronic Disease Risk Reduction Intake; EAR, Estimated Average Requirement; NA, not applicable (no UL set for these nutrients); RAE, retinol activity equivalents; UL, Tolerable Upper Intake Level; TMI, Target Median Intake; αT, α-tocopherol.
[2] Change in the intake distribution that is needed to achieve a 5% prevalence of inadequacy (3). For some nutrients, current intakes at the fifth percentile may be above the EAR, indicating that intakes could decrease and the prevalence of inadequacy would still be <5%.
[3] TMI is the median intake of the changed intake distribution and thus the minimum median intake needed to achieve a 5% prevalence of inadequacy; calculated as current median intake plus (or minus) the appropriate change.
[4] Published nutrients in a 1300-kcal/d USDA food pattern (16); the 1300-kcal/d pattern is the average of 1200- and 1400-kcal/d USDA food patterns.
[5] TMI for protein was calculated as g/kg × the median body weight of 16.1 kg for ages 2–4 y.
[6] An EAR has recently been set for calcium (600 mg/d) (15) so a revised TMI of 1047 mg/d can be calculated; median intakes would need to increase by 81 mg/d to meet the revised TMI. The new 95th percentile of intake would be 1672 mg/d, or 67% of the UL of 2500 mg/d.
[7] Using the new AI for potassium as the TMI (2100 mg/d) (15), median potassium intakes (2114 mg/d) would approximately equal the TMI, and a low prevalence of inadequacy could be assumed.
[8] Sodium TMI is based on the UL rather than the AI; if the new sodium CDRR (9) replaces the UL, then the revised TMI would be 1300 mg/d and median intake would need to decrease by 912 mg/d to equal the TMI.

In comparing the 95th percentiles of intake with the UL (Table 2), 6 nutrients were above the UL: vitamin A, niacin, folate, magnesium, zinc, and sodium. Sodium intake was particularly excessive, with 80% of usual intakes above the UL. Differences in nutrient forms and bioavailability could explain the apparently excessive intakes for 4 of these nutrients. These ULs apply to specific forms of nutrients, while the data in Table 2 show total intakes: the vitamin A UL applies only to preformed retinol, the magnesium UL applies only to pharmacological agents, and the niacin and folate ULs apply only to fortified foods and supplements (1). Projected zinc intakes above the UL may be overestimated because the zinc UL for children 2–3 y of age (7 mg/d) rather than the considerably higher UL for children 4 y of age (12 mg/d) was used.

Since these analyses were published, new DRIs were set for calcium in 2011 (15) and for sodium and potassium in 2019 (9). The calcium AI shown in Table 2 was changed to an EAR, although the original value was retained (a weighted average of 600 mg/d for 2- to 4-y-old children). The potassium AI was reduced from 3267 mg/d to 2100 mg/d for this age group (a weighted average of 2000 mg/d and 2300 mg/d), while the sodium AI was changed to 867 (a weighted average of 800 mg/d and 1000 mg/d). The sodium CDRR was set at 1300 mg/d, well below the UL of 1633 mg/d. Revised assessments showed that the prevalence of calcium inadequacy was >5%, while sodium inadequacy remained very low. Median potassium intake was slightly above the new AI and thus inadequacy could be assumed to be low. Almost 95% of sodium intakes were above the CDRR.

Setting TMIs (and checking ULs) for each nutrient

For the CACFP analyses, an early decision was made to aim for a prevalence of inadequacy of ≤5%, and a prevalence of potentially excessive intakes of <5%. To achieve these goals, TMIs for each nutrient were set for each age group.

For example, the data in Table 2 were used to set nutrient standards for feeding children in the 2- to 4-y-old age group. To achieve the goal of a prevalence of inadequacy of <5%, it is necessary for the fifth percentile of intake to be equal to (or greater than) the EAR. Thus, the intake distribution should be shifted to achieve this prevalence. Table 2 shows the fifth percentile of intake for each nutrient for children 2–4 y of age, and **Table 3** shows change in the fifth percentile that would be needed to achieve a 5% prevalence of inadequacy. For vitamin E, the fifth percentile of intake would need to increase by 3.2 mg/d to be equal to the EAR of 5.3 mg/d. Thus, 3.2 mg/day was added to the current median intake (3.9 mg/d) to give the TMI of 7.1 mg/d. Importantly, intakes of most nutrients with an EAR in Table 3 could be decreased and still achieve a low prevalence of inadequacy among children in this age group.

For nutrients with an AI, the prevalence of inadequacy cannot be determined, so the mean nutrient intake should be equal to the AI. Thus, the TMI is simply the AI, and the needed change in median intake is the difference between the current median intake and the AI. As shown in Table 3, intakes of potassium and fiber need to increase so that the median equals the TMI. For calcium, mean intakes could decrease to the AI, but the estimated prevalence of inadequacy could still be assumed to be low. If the revised AI for potassium is used, the TMI would be 2100 mg/d, which is approximately equal to the median intake. For calcium, intakes would need to increase by 81 mg/d, so that the fifth percentile of intake is equal to the EAR of 600 mg/d, and the TMI would increase to 1047 mg/d.

It is also important to ensure that increasing mean intakes to the TMI does not result in an undesirably high prevalence of intakes above the UL. For CACFP, the goal was to have the 95th percentile of the new distribution below the UL, so that <5% of the group would exceed it. As shown in Table 3, the 95th percentile for 6 nutrients would be above the UL: vitamin A, niacin, folate, magnesium, zinc, and sodium. These are the same 6 nutrients for which the 95th percentile of current intakes are above the UL (Table 2), although projected intakes of all 6 nutrients would be reduced using the TMIs as targets. As noted earlier, this is not likely to be a concern for most of these nutrients because the ULs apply to specific forms of nutrients while the data in Tables 2 and 3 show total intakes. However, it would be desirable to reduce median sodium intakes at least to the TMI, which was set at the UL. Since using the TMI as a target would reduce sodium intake by almost 600 mg/d compared with current intake levels (from 2212 mg/d to 1633 mg/d), it is still an important goal. Furthermore, intakes would need to be reduced even more if the new CDRR of 1300 mg/d is used as the TMI; the median intake exceeded this TMI by 912 mg/d. As noted in the IOM report, phased reductions in sodium intake should be considered (4).

Thus, the IOM report concluded that nutrients to increase in the diets of 2- to 4-y-old children were vitamin E, fiber, and potassium, while sodium intake should be decreased (4). If newer DRI values are used for calcium, potassium, and sodium, this list would be revised to include calcium and omit potassium.

Translating nutrient targets into foods

The CACFP analyses used the USDA food patterns based on the 2005 Dietary Guidelines (17) to help align the CACFP food selections with the TMIs. Food patterns are available for 12 calorie levels, ranging from 1000 kcal/d to 3200 kcal/d. The average energy requirement for children 2–4 y of age is ∼1300 kcal/d (Table 1), but there is no USDA food pattern for this specific energy requirement. Therefore, a food pattern was devised that averages the 1200- and 1400-kcal/d food patterns. Likewise, the nutrient content of the new pattern was calculated as the average of the published nutrient content of the 1200- and 1400-kcal/d patterns (16). These values are shown in Table 3 and may be compared to the TMIs calculated for children 2–4 y of age. The food pattern will supply at least the TMI for all but 2 nutrients: vitamin E and potassium. To increase intakes of vitamin E and potassium, foods rich in these nutrients should be chosen frequently when preparing menus for CACFP. The sodium level of the food pattern is also below the TMI, which is desirable since the UL was used to set the TMI.

It is interesting to note that the 2005 USDA food pattern shown in Table 3 contains sufficient potassium to meet a TMI of 2100 mg/d, which is based on revised AIs from 2019 (9), and also contains a sodium level that is below a revised TMI that is based on the CDRR described in the National Academies of Sciences, Engineering, and Medicine report (9). However, the USDA pattern does not contain sufficient calcium to meet a revised TMI of 1047 mg/d (15).

Converting daily food patterns into meal patterns

The final step in planning intakes for groups is to translate the nutrient targets into menus. Because the USDA food patterns provide the TMIs for almost all nutrients, these food patterns may be used as a starting point for daily food targets. Continuing with the example for 2- to 4-y-old children, Table 1 shows that a 1300-calorie meal pattern would be appropriate for this age group. Taking an average of the 1200- and 1400-kcal/d patterns, food-group amounts per day are as follows: 1.25 cups fruit, 1.5 cups vegetables, 4.5 ounce (oz)-equivalents of grains (an oz-equivalent is 0.5 cup cooked rice, pasta, cereal; 1 slice of bread; 1 oz ready-to-eat cereal), 3.5 oz-equivalents of meat and beans (an oz-equivalent is 1 oz of meat, poultry, or seafood; 1 egg; 0.5 cup cooked beans or tofu; 1 tablespoon of peanut butter; 0.5 oz nuts or seeds), and 2 cups milk (17).

These foods must then be distributed across 3 meals and 2 snacks, to correspond with the eating occasions used by CACFP. The percentage of calories at each meal and at snacks is shown in Table 1: 20%, 26%, 26%, and 28% at breakfast, lunch, supper, and snacks, respectively (14% at each of 2 snacks). Thus, approximately one-fifth of each food group should be served at breakfast, one-fourth at lunch and supper, and the rest at the 2 snacks. For practical reasons, it is not always possible to divide foods in this way, so adjustments must be made for the population being fed. For example, vegetables are not frequently served at breakfast, so 1.5 cups of vegetables was divided among the remaining eating occasions. Likewise, to keep portions sizes from being very small, meat is to be served at breakfast only 3 d/wk, and replaced with an additional oz-equivalent of grains on days without meat. Portion sizes were rounded up or down so that measuring was not complex. A more detailed discussion of the resulting CACFP food patterns has been published

(4, 18). For example, the lunch and supper meal pattern for 2- to 4-y-old children is 0.5 cup fruit, 0.5 cup vegetables, 1 oz-equivalent grains, 1 oz-equivalent meat, and 0.5 cup milk.

An additional complexity was introduced by the specification of weekly amounts for the vegetable subgroups in USDA meal patterns [dark-green vegetables (DGVs), orange vegetables, dry beans and peas, starchy vegetables, and other vegetables]. For example, the 1300-calorie food plan specifies 1.5 cups/wk of DGVs. Rather than try to serve small amounts of DGVs at each meal on each day, CACFP providers are asked to vary vegetable types across the meals and across the days. Snack patterns also must be varied across the day and the week, so that individual snacks do not contain too many items. Finally, weekly food-group targets must be adjusted to reflect the fact that CACFP does not provide for meals and snacks served on weekends. To address this issue, the weekly USDA food pattern vegetable targets were adjusted downward (by 5 out of 7 days, to ~70% of the weekly target).

Conclusions

The methods described here for planning nutrient intakes for groups follow the recommendations of both of the DRI Uses subcommittees (2, 3) and 2 consensus committees, one addressing revisions of the USDA school meals program (5) and the other focused on CACFP (4). This approach provides a scientifically valid basis for setting daily, meal-based nutrient targets that can be translated into nutritionally adequate meals and snacks, for both children and adults, across a day. These methods have been illustrated using the process that was followed by the IOM committee that recommended revisions to the CACFP nutrient standards.

Strengths and limitations of the approach

An important strength of the TMI approach described above is that the distribution of nutrient intakes is evaluated, not just the mean or median. As a result, TMIs can be set so that a small proportion of a group is below the EAR and a small proportion is above the UL (Figure 1). Because interindividual variations in nutrient intakes are typically large, a TMI is almost always above the RDA; using the RDA as the target intake would not ensure a low prevalence of inadequacy. However, the TMI approach requires that the distribution of nutrient intakes is known for the population of interest, but this type of data may not always be available. Distributions from a similar population may be used, if necessary, although an evaluation of the resulting feeding programs would be particularly important in this situation.

However, the TMI approach also has some limitations. For example, the TMI calculations assume that intakes at each point on the distribution will increase (or decrease) by the same amount after new nutrient targets are implemented. That is, the whole intake distribution will shift, but its shape will not change. Thus, it assumed that the change in intake that is needed at the fifth percentile is also the change in intake that is needed at the mean. This is largely an untested assumption and should be the focus of pilot studies and related research. It is also possible that a subset of the group will not be reached by changing the types of foods served to everyone. For example, very low intakes of a nutrient may reflect a poor appetite or food allergies, which might need to be addressed on an individual basis. Then, the group planning paradigm could be applied to the remaining participants.

Because there are no sex differences in DRIs for children ages ≤8 y, the example used here for preschool children aged 2–4 y does not address an additional complexity that is involved in setting TMIs for older children and adults. Furthermore, energy requirements tend to be considerably higher in males than in females. As a result, the nutrient density of the requirement (the ratio of the nutrient requirement to the energy requirement) is often higher for females. As explained in the IOM report on school meals (5), TMIs for older children were set using a nutrient density approach, so that females would receive adequate nutrients even though they have lower energy requirements and thus, on average, consume less food. The same process was followed for older children and adults in CACFP.

The CACFP analyses reported here also have strengths and limitations. For example, a strength is the use of national survey data that is representative of the US population to estimate current intakes. However, while subsamples representing either CACFP participants or low-income families would have been desirable, these samples were too small for the age groups of interest. Additionally, the multiple-pass method used to collect 2 d of recall data for each participant has been shown to have a relatively high level of accuracy (19), although underreporting of intakes remains a concern. An important finding of these analyses is that the calorically appropriate USDA food patterns that are recommended by the Dietary Guidelines for Americans (DGA) meet the TMIs for almost all nutrients within each age group. Using these food patterns as the basis of the CACFP meal patterns greatly simplified the conversion of nutrient targets into food-group targets. The Healthy Eating Index provides a summary measure of adherence to the Dietary Guidelines and might also be a useful tool for evaluating CACFP intakes in the future (20).

However, it is important to note that the specific food choices within each of the broader food categories must correspond to the USDA specifications for the food groups (e.g., foods should be in their lowest-fat, lowest-sugar forms); if not, the calorie level may be exceeded, and nutrient targets may not be met (21). Thus, to guide appropriate food selections, the CACFP committee developed a list of specifications for foods to include in the meals and snacks (4). Examples include the following: low-fat or nonfat milk, 100% fruit juice, and poultry without skin. While the USDA food patterns used for CACFP were originally based on the 2005 DGA (17), the IOM committee also considered expected changes in the food patterns with the 2010 DGA (22). These changes have been discussed (18), with the conclusion that they would have little impact on the CACFP recommendations. Although the food patterns were also slightly modified as part of the 2015 DGA release (23), no impact on the CACFP recommendations would be expected.

Although Tables 2 and 3 show how nutrient targets were developed for children ages 2–4.9 y, these analyses have been performed for 4 other age groups as well: children 1–1.9, 5–13.9, and 14–18.9 y, as well as adults aged ≥19 y. The results are reported in detail in the CACFP report (4) and in a paper on aligning nutrition-assistance programs with the DGAs (18). Meals and snacks were planned for a full day for each age group, assuming that all eating occasions would follow these patterns. However, except in emergency feeding situations, it is unlikely that participants would consume all of their food in a CACFP setting. Thus, to meet the daily nutrient targets, it is important that meals and snacks consumed outside CACFP provide foods conforming to the nutritional quality of CACFP. The CACFP guidelines are also intended to serve an educational role, providing a model for parents and adult participants that will help improve overall food choices.

Evaluation of the impact of planning nutrient intakes for groups

The meal and snack patterns from these analyses address what is served, not what is actually consumed by participants. Thus, an evaluation phase is essential in order to determine if the targets are actually being met. The CACFP report concluded with several evaluation and research recommendations, including the following questions that are particularly relevant to evaluating the impact of setting nutrient (and food) intake targets for groups (4):

- What may be the effect of the recommended targets on participants' nutrient intakes, both from meals and snacks served in care/program settings and across the day?
- Has the prevalence of inadequate or excessive nutrient intakes been improved?
- Do the age-range categories function effectively?
- Were the desired calorie intakes for each age group achieved?
- How did the distribution of energy intake per kilogram of body weight change?

These same questions could guide an evaluation of other feeding programs that are using the CACFP methodology. Importantly, planning and evaluation should be an iterative process, starting with smaller pilot studies utilizing the planning targets, followed by an evaluation phase, both of which are repeated as necessary before going to a full-scale operation.

Applications to other populations

These methods could be used in other settings to design nutrient and food intakes for a variety of population groups. However, it is important to recognize that the TMI is a population-specific goal because it is based on the distribution of intakes by the population of interest. Thus, the TMIs shown in Table 2 might not be appropriate for other groups of 2- to 4-y-old children, even in the United States. It is always more desirable to develop TMIs using intake data for the specific population of interest. For example, intake distributions are likely to differ by age, geographic location, cultural and racial categories, and access to food.

The procedures described here to develop TMIs may also be applicable in other countries, and for international population groups. In addition to basing these TMIs on intake data from the populations of interest, it may also be desirable to use nutrient reference values other than the DRIs for the United States and Canada. To facilitate the process of developing TMIs, and thus the design of food programs, a set of harmonized nutrient reference values has recently been proposed by Allen et al. (24). Harmonized EARs (referred to as Harmonized Average Requirements) are included for protein, 13 vitamins, and 12 minerals. When available, harmonized ULs are also specified.

Converting nutrient targets into food guidance is also likely to be population specific because food availability and food preferences can vary substantially across population groups. The protocol described here used the USDA food guides to assist in developing meal patterns. Because the USDA food guides are developed for the United States, food guides from other countries or regions are likely to be more appropriate when converting nutrient targets into food-based guidance for populations outside the United States.

The methods described here permit a science-based approach to setting nutrient targets for groups. Using these methods together with contemporary DRI values should result in a low prevalence of nutrient inadequacy as well as a low prevalence of excessive intakes within a group. This approach was first applied in order to develop recommendations for the school meals program, and then extended to all age groups when developing recommendations for child and adult care programs. Because CACFP serves a clientele of all ages, in many different settings, and across all eating occasions, it may be considered a model for developing nutrient and food targets for many types of programs serving population groups. Although the strengths and limitations of the methods should be considered, it is likely that such an approach will contribute to high-quality diets for those participating in a variety of food programs.

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