Household-level dietary quality indicator for countries in nutritional transition: application to vulnerable communities in El Salvador

Melissa Fuster[1], Robert F Houser[1], Ellen Messer[1], Patricia Palma de Fulladolsa[2], Hedi Deman[2] and Odilia I Bermudez[3],*

[1]Gerald J. and Dorothy R. Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA: [2]Regional Food and Nutrition Security Program for Central America, San Salvador, El Salvador: [3]Department of Public Health and Community Medicine, Tufts University School of Medicine, 136 Harrison Avenue, Boston, MA 02111, USA

Abstract

Objective: To develop a household-level diet quality indicator (HDQI) using the Salvadorian dietary guidelines to assess the dietary quality of households in vulnerable communities in El Salvador.
Design: The Salvadorian dietary guidelines were reviewed and eighteen HDQI components were identified (nine foods and nine nutrients). The components were evaluated using a proportional scoring system from 0 to 1, penalizing over- and under-consumption, where appropriate. The HDQI was validated in consultations with experts in El Salvador and by statistical analyses of the study sample data. Dietary variety and energy, nutrient and food intakes were compared among households above and below the median HDQI score using Student's *t* test.
Setting: Vulnerable, border communities in El Salvador.
Subjects: Households (*n* 140) provided food consumption information using an FFQ and sociodemographic data.
Results: The mean HDQI score was 63·5, ranging from 43·6 to 90·0. The indicator showed a positive, significant association with the dietary variety components. The statistical associations of the indicator with the energy and nutrient components were as expected.
Conclusions: Based on the indicator's demonstrated face validity and the results of the expert consultations, the indicator is suggested as a good measure of diet quality for households in El Salvador.

In developing countries, diet quality is frequently measured through diet variety indices (counts of unique foods or predefined food groups)[1], but variety is only one dimension of healthy eating[1,2]. These contexts are now showing an increased coexistence of diseases associated with overnutrition[3–6], alongside those associated with undernutrition[7–10], especially affecting the health of vulnerable segments of society[11]. This issue points to the importance of improving assessments of diet quality in developing countries. While existing indicators have been applied to samples in developing countries[12–15], differences in eating patterns affect the soundness of this approach. Many indicators are based on dietary guidelines of the countries in which they were developed[16–18], reflecting local food patterns and nutritional concerns and priorities expressed by experts of those countries. For example, as the US-based Healthy Eating Index (HEI)

penalizes the over-consumption of fats[16], it would mask deficiencies in fat intake still present in resource-poor settings. The Diet Quality Index-International (DQI-I)[19] partly addresses these issues, but it was developed for individual-level assessments and not for households. However, in developing countries data are collected at the household level, as individual-level data collection is prohibitive in cost. The development of a household-level indicator of dietary quality is a plausible solution to this problem, since studies comparing individual-level diet data with household-level data have found a close relationship between the two[20–23]. The current paper presents the Household Diet Quality Indicator (HDQI) for El Salvador, tackling the needs outlined above, as a household-level diet quality indicator addressing nutritional issues in a population undergoing nutritional transition. We applied the indicator to a sample

from vulnerable, potentially food-insecure communities in El Salvador.

Experimental methods

Study sample
The data used were collected in 2009 by the Regional Program of Food Security in Central America (PRESANCA) from a non-random sample of communities in border municipalities selected on the basis of high rates of chronic malnutrition and vulnerability from climatic and environmental conditions[24]. The original sample contained 167 households, but twenty-seven households with estimated energy intakes above 16 736 kJ/d per AE (4000 kcal/d per AE) were excluded from the analysis, resulting in a sample size of 140 households (855 individuals). The Tufts University Institutional Review Board granted exemption status for the study on July 2010, as a study based on secondary data analysis.

Food consumption assessment
Food consumption was assessed with a validated FFQ[25] collecting household intake in the 'previous week' of fifty-nine food items grouped into nine categories (basic grains, other grains, dairy/eggs, meats, vegetables, fruits, added fats, sugars, other miscellaneous foods). The questionnaire was administered by trained interviewers using open-ended questions to collect frequency of consumption and portion size. Completed questionnaires were checked for quality control. Nutrient intakes from foods reported in the FFQ were obtained using a composite nutrient database[26,27]. Energy requirements estimations were based on WHO recommendations[28]. 'Adult equivalents' (AE) were calculated following FAO procedures[29]. Analyses excluded household members younger than 1 year of age, as they are primarily breast-fed.

Development of the Household Diet Quality Indicator (HDQI)
The 2008 Salvadorian dietary guidelines (see Appendix)[30] were reviewed and eighteen components were identified (nine foods and nine nutrients). The components were quantified using WHO dietary goals for the prevention of chronic diseases and other resources[31–37]. Each component received a proportional score between 0 and 1, penalizing both over- and under-consumption, where appropriate (Table 1). The HDQI score was obtained by aggregating the component scores, and translated into a 100-point scale. Households were then split into two categories at the median.

Food-based component recommendations were quantified at the individual level using AE units. The grains and starchy vegetables component ('grains/starches') was quantified by aggregating the grains and starchy vegetables recommendations using the US Department of Agriculture's MyPlate food pattern based on a 11 715 kJ/d (2800 kcal/d) diet[37]. The bean, fruit and vegetable component scoring criteria were based on the WHO dietary goals for the prevention of chronic diseases[31]. Beans are one of the staple foods of the Salvadorian diet and the main source of protein for households without access to animal products. The WHO recommendation for fruit and vegetable intake[31] was divided into the two different components, as they contribute different benefits to the diet[38]. The fruit component assessed consumption of whole fruits only, and not juice. The dairy component recommendation was based directly on the Salvadorian dietary guidelines. Over-consumption was not penalized because of the importance of milk products as a source of calcium. Eggs were assessed separately from dairy, as an important source of animal protein. The recommendation was based on the Salvadorian and WHO recommendations[30,31] and an upper limit was set based on recent cholesterol recommendations[39]. The meat component reflects the minimum established by the Salvadorian guidelines and concerns kidney problems and obesity associated with excess consumption[40], with an upper limit based on the American Heart Association recommendations[35]. Finally, the HDQI assessed intake of high-energy, low-nutrient-density (HELND) foods (sweets and manufactured snacks) using frequency and intake of sugar-sweetened beverages (SSB; fruit and carbonated drinks) using the Harvard Healthy Beverage Plan[36] (Table 1).

Nutrient-based components were calculated using WHO recommendations[31,32], based on total household energy intake (EI) or by aggregating the individual household member recommendations, except in the case of fibre, where AE were used. Scoring of these components penalized excess and deficient consumptions, except in the case of saturated fat, sodium and simple sugars, where only excesses were penalized. Deficient intakes in total fat (<15 % of EI) were penalized because of the importance of this nutrient for fat-soluble vitamin absorption and other bodily functions. Upper levels for total fat, saturated fat and sodium used the ones established in the HEI[17]. No source was available to establish an upper level for simple sugars; therefore we used a 50 % increase from the established recommendation as the upper limit for this component. Simple sugars included those added to foods (sugar, honey, jams) and those coming from drinks (sodas, juices) and food (ice cream, cookies, candy) sources. Excess fibre consumption was penalized given the high wholegrain intake in this population and the potential for gastrointestinal discomfort and reduced mineral bioavailability[41,42]. The vitamin A, calcium, iron and zinc components were assessed based on WHO recommendations[32], using 'moderate' (30 %) bioavailability for zinc and 10 % bioavailability for iron[32]. Individual nutrient recommendations were aggregated and compared with the household intake using a proportion of recommendation consumed ratio (PRCR), where PRCR < 1 indicated an intake below

Table 1 HDQI quantification and scoring criteria by component

		Scoring criteria		
		0	1	0
Component	Guideline recommendation	Deficient	Recommendation	Excess
Grains & starchy vegetables	'Include grains, roots and plantains at all meal times'	0	11 portions/person per d	n/a
Beans	'Eat beans every day'	0	30 g/person per d (dry)	n/a
Fruits	'Eat fruits in season every day'	0	200 g/person per d	n/a
Vegetables	'Eat vegetables and leafy greens every day'	0	200 g/person per d	n/a
Milk and dairy	'Eat milk and milk products at least three times a week'	0	3 servings/person per week	n/a
Eggs	'Eat eggs at least three times a week'	0	3–4 eggs/person per week	8/person per week
Meat	'Eat meat, liver or other animal parts at least once a week'	0	1–14 servings/person per week	>21 servings/person per week
HELND foods	'Avoid consuming fatty foods, processed foods and fast foods'	n/a	0/week	2 times/week
SSB	'Avoid consuming sodas and artificial beverages'	n/a	0 fluid ounces/person per week	8 fluid ounces/person per week
Total fat	'Avoid eating greasy foods and fast foods'	0	15–35 % of EI	>45 % of EI
Saturated fat	(Not directly addressed in guidelines)	n/a	<10 % of EI	>15 % of EI
Sodium	'Eat salt in moderation', 'Avoid the consumption of processed foods and fast foods'	n/a	<2000 mg/person per d	>4800 mg/person per d
Simple sugars	'Avoid sweets and sodas'	n/a	<10 % of EI	>15 % of EI
Fibre	'Increase fibre intake'	0	27–40 g/person per d	>50 g/person per d
Vitamin A	'Include at least one food rich in vitamin A as part of the daily food consumption'	0	200–850 μg/person per d	600–3000 μg/person per d
Iron	'Include iron-rich foods as part of the daily food consumption'	0	5·8–15 mg/person per d (10 % bioavailability)	40–45 mg/person per d
Zinc	'Include at least one zinc-rich food in the daily food consumption'	0	4·1–8·5 mg/person per d (moderate bioavailability)	7–40 mg/person per d
Calcium	(Recommendation of dairy products)	0	500–1300 mg/person per d	2500 mg/person per d

HDQI, Household Dietary Quality Indicator; HELND, high-energy, low-nutrient-density; SSB, sugar-sweetened beverages; EI, energy intake; n/a, not applicable.

the recommendation. Excess intakes for these micronutrients were assessed by aggregating individual upper tolerable levels (UL), set by age/gender group[43], at the household level and calculating an excess consumption ratio (ECR), based on household recommendations. If the PRCR exceeded the ECR, the household was classified as exceeding the recommendation, and received a score of zero for the component.

Expert consultation

In 2011, twenty-eight representatives with an average of 15 years of experience working with nutrition and food security issues reviewed a first proposal for the HDQI. The organizations represented included academic institutions, government agencies and professional associations. Experts reported high agreement with the indicator as a measure of diet quality for Salvadorian households (88%). Feedback collected during this consultation was used in the final development of the indicator.

Statistical analyses

The data were analysed using the statistical software package Stata/IC 11·2. The HDQI distribution was assessed through skewness and kurtosis analysis. Spearman rank-order correlation was used to measure inter-item correlations between the indicator components. Household intakes for each component were classified according to the level of adherence with the HDQI recommendations (adherent, below or above recommended intake range). In the case of vitamin A, calcium, zinc and iron, households were classified as above the recommendation if consumption was more than two times the recommendation. Variety indicators were used to assess the indicator's face validity[6], including the number of different predefined food groups consumed (grains/starches, beans, fruit, vegetables, eggs, dairy, added fats, meat), the total number of unique foods consumed and the variety within selected food groups. Student's independent-samples *t* tests and correlations were used to compare these variety indicators and nutrient and energy intakes between households with scores above and below the median.

Results

Most households were located in rural areas, with married, male household heads and agriculture as the primary source of income (Table 2). Most households (79·3%) presented both deficiencies and excesses in consumption in at least one HDQI component. Adherence was high for the bean, sodium and saturated fat components. Almost all of the households were below the recommended intake for vegetables, calcium and fruits. Household intakes were above recommended levels notably for simple sugars, HELND foods and vitamin A (Table 3). The consumption of vitamin A was highly correlated with the consumption of

Table 2 Household- and individual-level demographic characteristics of the study sample; 140 households (855 individuals) from vulnerable, border communities in El Salvador, 2009

Household characteristics (*n* 140)	
Rural household (%)	92·8
Male head of household (%)	84·9
Married head of household (%)	83·5
Agriculture as main source of income (%)	63·3
Total number of household members	
Mean	5·4
SE	0·13
Individual characteristics (*n* 855)	
Age distribution† (%)	
1–4 years of age	10·5
5–9 years of age	16·3
10–19 years of age	27·4
20–59 years of age	40·8
60+ years of age	5·0
Gender distribution† (%)	
Male	46·6
Female	53·4

†Children younger than 1 year of age were excluded from the analysis.

simple sugars ($\rho = 0·84$, $P < 0·00$). About one-third of households (33·6%) exceeded the upper limit for simple sugar consumption. Four households (2·9%) exceeded the UL for vitamin A. While more than half of the households presented intakes within the recommended range for total fat, 30% of households failed to consume the minimum recommendation. The consumption of dairy and meat was low, but the egg consumption showed intakes above and below the recommendation (Table 3). Also, thirty-three (23·6%) households exceeded the upper intake limit (data not shown). The bean component presented the highest mean score (0·93) and the egg component presented the lowest (0·34). Inter-component correlations were low or moderate[44], with the highest correlation shown between the saturated fat and sodium component scores ($\rho = 0·5$, $P < 0·05$). The resulting mean HDQI score was 63·5 (SD 8·7, range 43·6–90·0). The HDQI score was normally distributed (skewness/kurtosis test for normality, $P = 0·38$). Households were split evenly above and below the median score (62·7, interquartile range 11·53), with seventy households in each category. Households above the median had a mean HDQI score of 70·5 (SD 5·9, range 62·7–90·0). Households below the median had a mean score of 56·5 (SD 4·5, range 43·6–62·7).

The sample had a mean energy intake of 9234 (SD 3330; range 760–3968) kJ/d per AE. Households with HDQI scores above the median had a mean energy intake of 9406 (SD 2866) kJ/d per AE, while the households below the median had a mean intake of 9058 (SD 3753) kJ/d per AE. These differences were not significant ($t = -0·62$, $P = 0·54$) and energy intake was weakly correlated with the HDQI score ($\rho = 0·23$, $P = 0·007$).

Diet variety was low, especially when measured as the count of unique foods consumed. Variety indicators were significantly different between households with HDQI scores above and below the median, except for variety in the grains/starches and SSB. Households

Table 3 Food intakes by HDQI component: mean component intakes and their standard errors, evaluation of intakes according to HDQI criteria and resulting mean individual scores and their standard errors; 140 households (855 individuals) from vulnerable, border communities in El Salvador, 2009

| | | Intake | | Intake classification according recommendation | | | | | | Resulting score | |
| | | | | Below | | Adherent | | Above | | | |
Component	Unit	Mean	SE	n	%	n	%	n	%	Mean	SE
Grains/starches	servings/person per d	10·9	0·4	78	55·7	62	44·3	n/a	–	0·82	0·02
Beans	g/person per d	102·4	6·1	16	11·4	124	88·6	n/a	–	0·93	0·02
Fruits	g/person per d	178·3	25·4	107	76·4	33	23·6	n/a	–	0·42	0·03
Vegetables	g/person per d	89·8	7·7	129	92·1	11	7·9	n/a	–	0·40	0·03
Milk and dairy	servings/person per week	6·2	1·1	87	62·1	53	37·9	n/a	–	0·51	0·04
Eggs	eggs/person per week	5·1	0·5	76	54·3	11	7·9	53	37·9	0·34	0·03
Meat	servings/person per week	2·4	0·3	74	52·9	65	46·4	1	0·7	0·47	0·04
HELND foods	frequency/week	1·7	0·2	n/a	–	75	53·6	65	46·4	0·63	0·04
SSB	fluid ounces/person per week	9·6	1·9	n/a	–	93	66·4	47	33·6	0·71	0·04
Total fat	% of EI	22·9	0·9	42	30·0	75	53·6	23	16·4	0·82	0·02
Saturated fat	% of EI	7·88	0·5	n/a	–	98	70·0	42	30·0	0·79	0·03
Sodium	mg/person per d	1822	111	n/a	–	102	72·9	38	27·1	0·86	0·02
Simple sugars	% of EI	12·9	0·6	n/a	–	62	44·3	78	55·7	0·56	0·04
Fibre	g/person per d	35·8	1·1	40	28·6	52	37·1	48	34·3	0·71	0·03
Vitamin A	μg/person per d	1358	70	24	17·1	53	37·9	63	45·0	0·56	0·02
Iron	mg/person per d	18·1	1·2	91	65·0	43	30·7	6	4·3	0·67	0·02
Zinc	mg/person per d	7·0	0·3	78	55·7	55	39·3	7	5·0	0·67	0·02
Calcium	mg/person per d	789·0	38·2	115	82·1	24	17·1	1	0·7	0·56	0·01

HDQI, Household Dietary Quality Indicator; HELND, high-energy, low-nutrient-density; SSB, sugar-sweetened beverages; EI, energy intake; n/a, not applicable.
Mean intakes were calculated using adult equivalents, where appropriate.

with scores above the median presented more varied diets *v.* households with below-median score, except in the case of HELDN foods where variety was lower (Table 4). Correlation analysis showed that the HDQI score was positively associated with variety in unique foods, food groups, unique number of fruits and meats consumed, and negatively associated with variety in HELND foods and SSB (Table 4). The HDQI was significantly and positively associated with protein, vitamin C and potassium intakes (Table 5).

Discussion

The HDQI was applied to resource-poor Salvadorian households, revealing a relatively low diet quality. Low ratings for the HDQI score came from both excesses and deficiencies, stressing the need to meet nutritional requirements within recommended ranges. Excesses were found in vitamin A, iron, eggs and sugar consumption, while the deficiencies came from not eating enough fruit, vegetables, meats, dairy and total fat, and in some households, eggs. This reflects the unique feature of this indicator. For example, if excesses in micronutrients and deficiencies in total fat had not been penalized, these would have been masked by higher HDQI scores. Therefore, the indicator underscores the importance of assessing both spectrums of consumption, especially in populations at risk of excess and deficient consumption for certain nutrients. The high consumption of simple sugars raises the risk of vitamin A toxicity in some households given El

Salvador's mandatory sugar fortification policy[45]. Household intakes were within the recommendations for sodium and saturated fat components. However, as sodium assessment did not include added salt at the table, there might be an underestimation in this component.

The indicator behaved as expected and there is no evidence that the indicator is biased towards households consuming more energy. The HDQI was positively correlated with overall diet variety indicators and negatively correlated with indicators of a low quality diet (variety in HELND foods and SSB). However, the indicator was not correlated with the different types of fat (Table 5). While the overall sample presented low fat intakes, this issue may also be indicative that the HDQI is not capturing differences between fats. More studies are needed to test and refine the indicator with samples presenting more variability in diets and diet quality.

The study had some limitations associated with the use of an FFQ and secondary data analysis. Food intake was collected for a 1-week period, which may not be indicative of the usual diet. The predetermined number of food items in the FFQ may cause measured intakes to differ from actual intakes. FFQ are limited by recall bias. Food consumption was collected at the household level and we do not have information on who was present during the FFQ administration, which may reduce the accuracy of the information reported. As the HDQI is a household-level indicator, results should not be extrapolated to individuals living in the household, as intra-household food allocation might affect individual-level diet quality. In addition, the use of secondary data did not allow

Table 4 Mean dietary variety indicators (overall and by HDQI classification) with their standard errors and correlation with HDQI score; 140 households (855 individuals) from vulnerable, border communities in El Salvador, 2009

| | | Mean intake | | | | | | | | | |
| | | Overall (n 140) | | | | HDQI score above median (n 70) | | HDQI score below median (n 70) | | Spearman correlation with HDQI | |
Variable	Possible max	Mean	SE	Min	Max	Mean	SE	Mean	SE	ρ	P
Total number of unique foods	59	17·3	0·54	2	32	18·6	0·68	16·1*	0·82	0·22	0·01
Total number of food groups	8	6·5	0·12	2	8	7·1	0·12	5·9*	0·18	0·50	<0·001
Number of unique foods within selected food groups											
Grains/starches	16	4·2	0·15	1	9	4·3	0·23	4·0	0·20	0·13	NS
Meat	3	0·6	0·06	0	3	0·8	0·08	0·4*	0·09	0·40	<0·001
Vegetables	11	4·1	0·19	0	9	4·6	0·25	3·6*	0·26	0·19	0·02
Fruits	6	1·4	0·08	0	3	1·7	0·10	1·0*	0·10	0·41	<0·001
HELND foods	4	0·8	0·08	0	4	0·6	0·13	0·9*	0·10	−0·17	0·04
SSB	3	0·5	0·06	0	3	0·4	0·09	0·5	0·08	−0·17	0·04

HDQI, Household Dietary Quality Indicator; HELND, high-energy, low-nutrient-density; SSB, sugar-sweetened beverages
Mean values were significantly different from those of households with HDQI score above the median: *$P < 0.05$.

Table 5 Mean intakes of selected nutrients (overall and by HDQI classification) with their standard errors and correlation with HDQI per adult equivalent unit; 140 households (855 individuals) from vulnerable, border communities in El Salvador, 2009

| | Mean intake | | | | | | | |
| | Overall intake | | HDQI score above median (n 70) | | HDQI score below median (n 70) | | Spearman correlation with HDQI | |
Nutrient	Mean	SE	Mean	SE	Mean	SE	ρ	P
Protein (g)	63	2	67	3	60	4	0·20	0·015
Carbohydrate (g)	364	10	374	14	355	16	0·10	NS
Total fat (g)	61	4	60	4	62	6	0·10	NS
Saturated fat (g)	22	2	22	2	22	3	0·14	NS
Monounsaturated fat (g)	18	1	17	1	19	2	0·11	NS
Polyunsaturated fat (g)	16	1	16	1	17	1	0·04	NS
Vitamin E (mg)	6·6	0·4	6·6	0·5	6·5	0·5	0·08	NS
Vitamin C (mg)	51	5	60	7	43	7	0·31	<0·001
Folate (μg)	542	27	559	29	525	45	0·13	NS
Potassium (mg)	3422	114	3769	147	3074*	165	0·31	<0·001

HDQI, Household Dietary Quality Indicator.
Mean values were significantly different from those of households with HDQI score above the median: *$P < 0.05$.

assessment of other healthy living recommendations found in the Salvadorian dietary guidelines (water intake, weight control, processed food consumption). The assessment of 'processed' foods is especially important in the context of nutritional transition, due to the high fat and sodium content[8,46]. Future research should include dietary assessment tools that collect this information. Another factor to consider is the intake of dietary supplements and micronutrient supplementation for children under 5 years of age and pregnant/lactating women. Although the use of dietary supplementation may not be widespread in the sample included in the present study, future studies in more affluent settings should collect this information.

The strength of the HDQI is that it assesses diet quality in households beyond energy adequacy and variety measures alone, commonly used in developing country settings. The results presented herein contribute to the literature by calling attention to the possibility of both deficiencies and excesses in vulnerable, potentially food-insecure households in countries undergoing epidemio-logical and nutritional transitions. Consultations with experts resulted in local approval of the HDQI and enthusiasm for possible applications in El Salvador. While the HDQI could be used as a measure of adherence to the dietary guidelines, the indicator was constructed as a measure of diet quality informed by the guidelines. Future revisions of the indicator should occur, in conjunction with future revisions of the dietary guidelines, with the potential to include more recommendations addressing the growing rate of diet-related non-communicable chronic diseases. More research is needed to continue testing the HDQI against anthropometric and health indicators. Future research could also explore the application of the HDQI in other regions of Latin America with similar dietary patterns and concerns as those found in El Salvador.

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Appendix

Dietary guidelines for El Salvador: general messages[29] *(author translation)*

1. Eat a varied diet
2. Include grains, root crops and plantains in all meals
3. Eat tortillas and beans every day
4. Eat vegetables and leafy greens every day
5. Include fruits in season as part of your daily food consumption
6. Eat eggs, milk and milk products at least three times a week
7. Eat meats, liver or other entrails at least once a week
8. Make sure the salt you consume is fortified with iodine
9. Make sure the sugar you consume is fortified with vitamin A
10. Drink plenty of water every day