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We are how much we Eat: Nutrient-Specific Versus Calorie-Based Adult-Equivalent Scales

Mohammad Ali[1] ✉
Kira M. Villa[2]

(✉ Corresponding Author)

[1]*Centenary College of Louisiana, United States.*
Email: mali@centenary.edu Tel: (+1)505-720-9017
[2]*University of New Mexico, United States.*
Email: kmvilla@unm.edu Tel: (+1)505-277-5304

Abstract

The accurate conversion of household-level food availability into individual-level nutrient availability depends on which adult-equivalent scale is employed. The purpose of this paper is to come up with a set of adult-equivalent scales based on the specific daily intake requirement for macro- and micronutrients. Using t-tests on household-level data from Nepal, we also attempt to find whether on average there are differences between the individual-level nutrient availability estimates when they are calculated through nutrient-specific versus calorie-based, per capita, or Organization for Economic Cooperation and Development (OECD) adult-equivalent scales. The results suggest that on average there are significant differences between the individual-level nutrient availability estimates depending on which adult-equivalent scale is used. Finally, we find that nutrient-income elasticities calculated through different adult-equivalent scales are statistically different from each other. Thus, the nutrient-specific adult-equivalent scales derived in this paper have the potential to reduce measurement error in future studies.

Keywords: Nutrient availability, Adult-equivalent scales, Nepal, Micronutrients, Nutrient-income elasticities, Food expenditures.

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Contents

1. Introduction **33**
2. Methods **33**
3. Results **35**
4. Conclusion **37**
References **37**

Contribution of this paper to the literature
Our contribution in this research is to calculate nutrient-specific adult-equivalent scales that will enable researchers to more accurately translate food availability data from household surveys to macro- and micronutrient availabilities per adult male equivalent. Using these nutrient-specific adult-equivalent scales will potentially reduce measurement error in future studies.

1. Introduction

Household-level surveys often contain food modules that collect information on household food availability (i.e., the total amount of food available to a household at a given time) in the form of food expenditures [1]. Although not as precise as food frequency questionnaires (FFQs), household-level food expenditure modules are commonly employed because they are cheaper and less timely to collect than individual food consumption data [2, 3]. Food expenditure can then be used to estimate individual food/nutrient *availability*, where individual-level availability is calculated as the total amount of food/nutrients available to the household divided by the number of household members [4-6].

However, per capita food/nutrient availability is not comparable across households with different demographic compositions as the cost of an optimal consumption basket for an individual household member depends on that member's age and sex. Consequently, many use some version of a cost-based adult equivalency scale [7]. Commonly used cost-based equivalence scales, such as the Organization for Economic Co-operation and Development (OECD) scale [8] are generally developed for overall household consumption or expenditure (not just household nutrient availability). They also typically assume the existence of economies of scale (e.g., buying in bulk can be cheaper per unit than buying in small amounts). For example, the OECD scale assumes that additional adults are equivalent to 0.5 of the first adult. While this is a reasonable assumption for cost-based measures and analysis, economies of scale do not exist for nutrient availability. Moving from a one adult to a two adult household (each with the same nutrient requirements) requires that the household's nutrient availability must double (not increase by 0.5). For these reasons, cost-based adult equivalency scales are generally not appropriate tools for measuring nutrient availability in a household.

While cost-based adult equivalency scales are the most common, some instead employ nutrition-based equivalency scales. However, the only nutrition-based adult-equivalent scales, that we are aware of e.g. Claro, et al. [9] are based on the calorie requirements of different age groups and sex. Calorie-based adult-equivalent scales are an improvement from per capita measures and cost-based equivalency scales and are perfect for calculating individual-level calorie availability However, they still can lead to unreliable estimates of the availability for other nutrients such as macro- (fats, carbohydrates, and proteins) and micronutrients (vitamins and minerals). This gap is notable as micronutrient deficiency is currently a bigger problem than calorie deficiency in most developing countries [10]. Therefore, employing a measure using only caloric conversion rates may miss an important dimension of nutrient availability. Any adult-equivalent scale based on caloric requirements by sex and age will not correctly calculate the individual-level micronutrient availability per adult equivalent within a household. Therefore, having accurate conversion factors for other vital nutrients is important to better understand disparities in nutrient availability and food security in developing countries and is necessary for comparing nutrient availability across households with different compositions and size [11, 12].

In this paper, we propose nutrient-specific adult-equivalent scale using the daily nutrient intake guidelines provided by the Institute of Medicine [13]. This scale provides a more accurate representation of individual-level nutrient availability within a household relative to the nutrient needs of that household. We also calculate the magnitude of the difference in estimated daily nutrient availabilities when using our nutrient-specific scale compared to calorie-based, per capita, and OECD adult equivalent scales with data from the third round of the Nepal Living Standards Survey (NLSS III). Thus, our contribution is two-fold. First, the calculation of nutrient-specific adult-equivalent scales will enable researchers to accurately translate food availability data from household surveys to macro- and micronutrient availabilities per adult male equivalent. Second, this paper also provides an estimate of the difference in the calculation of daily individual-level nutrient availabilities if the commonly used calorie-based, per capita, and OECD adult equivalent scales are used instead of those that are nutrient-specific.

We find that on average there are significant differences in the individual-level daily nutrient availability estimates when they are calculated using the nutrient-specific adult-equivalent scale proposed in this paper compared to the other commonly used (calorie-based, per capita, and OECD) adult equivalent scales. Importantly, we find that the average difference is also not just in one direction, as in the use of calorie-based, per capita, and OECD adult equivalent scales over- or under-calculates the mean nutrient availability depending on each specific nutrient. Thus, our study provides a much more accurate benchmark for future studies using household survey data to calculate individual-level nutrient availability estimates.

2. Methods

2.1. Data

To empirically explore variation in measured nutrient availability based on different adult equivalency scales, we use data from NLSS III collected in 2010-2011. NLSS III consists of a total of 5,988 household-level observations but missing observations reduces our sample to 4,425 households. NLSS III includes a food module containing information on weekly household food availability based on foods obtained through home production, market purchases, and in-kind receipts. We use this food availability data to calculate daily household-level nutrient availability using the reference tables provided by the United States Department of Agriculture (USDA) National Nutrient Database for Standard Reference [14]. The nutrients for which we calculate the daily household nutrient availability are proteins, carbohydrates, vitamins A, C, B1 (thiamin), B2 (riboflavin), B3 (niacin), B6, B9 (folic acid), B12, calcium, iron, and zinc. We select these macro- and micronutrients, as they are important protective and growth nutrients needed to maintain healthy bodily functions such as bone growth and brain activity [15].

After calculating the daily household-level nutrient availability, we convert it into four measures of average individual-level availability for each household using a calorie-based scale (proposed by Claro, et al. [9]) a per capita approach, the OECD scale, and the nutrient-specific scale we propose in this paper. Using these, we construct three variables equal to the difference between individual-level daily nutrient availability constructed with our nutrient-specific adult-equivalent scale and that based on the calorie-based, per capita, and OECD adult-equivalent scales respectively. Further explanation of how these difference variables are used is provided in the next sections of this paper.

2.2. Nutrient-Specific Adult-Equivalent Scales

We construct nutrient-specific male adult equivalent scales using the daily nutrient intake guidelines provided by the Institute of Medicine [13][1]. These guidelines provide the daily intake recommendations for all the macro- and micronutrients analyzed in this paper, accounting for age and sex differences. Based on the age-specific guidelines proposed by Institute of Medicine [13] we construct our scale for the following age groups: 1-3, 4-8, 9-13, 14-18, 19-30, 31-50, and over 50 years of age. For each age group, other than the 1-3 year-olds, the daily intake recommendations also differ by sex.

To estimate the nutrient-specific adult-equivalent scales, we use the daily nutrient recommendation for males in the 19-30 age group for each nutrient as the reference value to which the daily recommendation for all other age and sex groups is compared—making our scale a measure of nutrient availability per adult male equivalent in the household. Accordingly, the adult-equivalent conversions for each nutrient were computed by dividing the daily recommendation for each age and sex group with the reference value for that specific nutrient. Since, according to the Institute of Medicine's guidelines, the vitamin D and carbohydrates recommendations do not change with age or sex, we do not include these nutrients in Table 1 as their conversion scale are equal to one for all categories.

Table 1 details the nutrient-specific adult equivalent scales calculated using the above methodology. A close look at Table 1 suggests that the male adult equivalent conversion scales for every sex and age group vary considerably across the different nutrients. This implies that even the use of a calorie-based adult-equivalent scale can over- or underestimate nutrient availability per male adult equivalent depending on the nutrient. Table 2 provides the calorie-based and OECD adult-equivalent scales for different ages. Because a per-capita measure simply divides household-level nutrient availability by household size, the conversion scale under this approach is simply one for all demographic categories. It is important to keep in mind that these scales do not differentiate between different macro- and micronutrients.

Table 1. Nutrient-specific adult-equivalent scales.

Ages	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
	Proteins	**A**	**C**	**B1**	**B2**	**B3**	**B6**	**B9**	**B12**	**Calcium**	**Iron**	**Zinc**
Child (1-3)	0.23	0.33	0.17	0.42	0.38	0.375	0.38	0.375	0.375	0.7	0.875	0.27
Female (4-8)	0.34	0.44	0.28	0.5	0.46	0.5	0.46	0.5	0.5	1	1.25	0.45
Male (4-8)	0.34	0.44	0.28	0.5	0.46	0.5	0.46	0.5	0.5	1	1.25	0.45
Female (9-13)	0.61	0.67	0.5	0.75	0.69	0.75	0.77	0.75	0.75	1.3	1	0.73
Male (9-13)	0.61	0.67	0.5	0.75	0.69	0.75	0.77	0.75	0.75	1.3	1	0.73
Female (14-18)	0.82	0.78	0.72	0.83	0.77	0.875	0.92	1	1	1.3	1.875	0.82
Male (14-18)	0.93	1	0.83	1	1	1	1	1	1	1.3	1.375	1
Female (19-30)	0.82	0.78	0.78	0.92	0.85	0.875	1	1	1	1	2.25	0.73
Male (19-30)	1	1	1	1	1	1	1	1	1	1	1	1
Female (31-50)	0.82	0.78	0.78	0.92	0.85	0.875	1	1	1	1	2.25	0.73
Male (31-50)	1	1	1	1	1	1	1	1	1	1	1	1
Female (>50)	0.82	0.78	0.78	0.92	0.85	0.875	1.15	1	1	1.2	1	0.73
Male (>50)	1	1	1	1	1	1	1.31	1	1	1	1	1

Table 2. Calorie-based and OECD adult-equivalent scales.

Ages	**(1)**		**(2)**
	Calorie-Based	**Ages**	**OECD**
Infants (0-1)	0.29	Household Head	1
Child (1-3)	0.51	Child (0-3)	0.3
Child (4-6)	0.71	Child (4-6)	0.3
Child (7-10)	0.78	Child (7-10)	0.3
Female (11-14)	0.86	Female (11-14)	0.3
Male (11-14)	0.98	Male (11-14)	0.3
Female (15-18)	0.86	Female (15-17)	0.3
Male (15-18)	1.18	Male (15-17)	0.3
Female (19-24)	0.86	Female (18-24)	0.5
Male (19-24)	1.14	Male (18-24)	0.5
Female (25-50)	0.86	Female (25-50)	0.5
Male (25-50)	1.14	Male (25-50)	0.5
Female (>50)	0.75	Female (>50)	0.5
Male (>50)	0.9	Male (>50)	0.5

2.3. Differences between Cost-Based, Calorie-Based, and Nutrient-Specific Scales

We compare average household nutrient availability per adult male equivalent based on three different equivalency scales. Specifically, we examine the difference between estimated average individual daily nutrient availability based on our nutrient-specific equivalent scale and that based on calorie-based (via Claro, et al. [9]) per capita, and the OECD adult equivalent scales respectively. We do this for each nutrient and test whether the means of these differences are equal to zero. Thus, our hypotheses can be defined as:

[1] We do not calculate a nutrient-specific adult-equivalent scale for fats in this paper as the Institute of Medicine does not provide fat intake recommendations across demographic categories.

$$H_0: Diff\_Nutrient_{hi} = 0 \quad (1)$$

Where $Diff\_Nutrient$ is the difference obtained by subtracting measures of daily individual-level nutrient availability calculated with the calorie-based, per capita, and OECD adult equivalent scales from the daily individual-level nutrient availability calculated with the nutrient-specific scale for each nutrient i in household h. The t-statistics obtained from the testing of these hypotheses will reveal whether the difference between the individual-level nutrient availabilities calculated through the nutrient-specific adult-equivalent scale are on average significantly different from those calculated through other (calorie-based, per capita, or OECD) adult-equivalent scales. Thus, if the null hypotheses are rejected, it would imply that nutrient availability estimates obtained from the above-mentioned adult-equivalent scales are on average different from each other.

3. Results

Table 3[2] reports average daily nutrient availability per household male equivalent based on each of the three adult equivalency scales—specifically, the nutrient-specific (column 2), calorie-based (column 3), per capita (column 4), and OECD (column 5) adult-equivalent scales. Column 1 of Table 3 reports the daily recommendation of each nutrient for an adult male, for reference. Because the average nutrient availability units reported in Columns 3-5 are in adult male equivalents, estimated availabilities can be compared to the daily recommendations reported in column 1. Thus, if a household's nutrient availability calculated with the nutrient-specific scale is lower than the daily recommendation reported in column 1, then the household is deficient in that nutrient (i.e., the household does not have enough of that nutrient available to meet the daily requirement of all of its members). Strikingly, we see that depending on the nutrient some equivalence scales indicate that the household has a surplus (shortage) of the nutrient when the household is actually deficient (sufficient) in it. For example, the OECD scale indicates average Vitamin C availability is sufficient when it is actually below the daily recommendation when using the more accurate nutrient-specific scale. Conversely, the per capita scale indicates that households are, on average, deficient in protein when there is actually a small surplus of protein, on average.

Table 3. Summary statistics for nutrient availability from different scales.

Nutrients	Daily Requirement (1)	Nutrient-Specific (2)	Calorie Based (3)	Per Capita (4)	OECD (5)
Carbohydrates (g)	130	337.0	373.6	337.0	596.7
		(160.1)	(171.9)	(160.1)	(280.3)
Proteins (g)	56	62.17	53.32	48.14	84.82
		(30.34)	(24.97)	(23.38)	(39.34)
Vitamin A (mcg)	900	133.5	117.7	106.7	182.9
		(138.9)	(120.9)	(114.8)	(178.1)
Vitamin C (mg)	80	65.47	53.30	48.62	83.53
		(71.59)	(57.40)	(54.29)	(87.58)
Vitamin D (mcg)	15	0.416	0.456	0.416	0.721
		(0.559)	(0.580)	(0.559)	(0.909)
Vitamin B1 (mg)	1.2	2.229	2.113	1.909	3.369
		(1.045)	(0.962)	(0.907)	(1.547)
Vitamin B2 (mg)	1.3	0.848	0.772	0.697	1.220
		(0.529)	(0.486)	(0.447)	(0.729)
Vitamin B3 (mg)	16	23.45	21.83	19.70	34.90
		(11.51)	(10.32)	9.609	(16.91)
Vitamin B6 (mg)	1.3	2.187	2.232	2.013	3.565
		(1.148)	(1.136)	(1.057)	(1.847)
Vitamin B9 (mcg)	400	599.2	589.2	538.5	927.6
		(626.2)	(611.4)	(573.9)	(948.4)
Vitamin B12 (mcg)	2.4	1.005	0.994	0.898	1.556
		(0.998)	(0.993)	(0.913)	(1.488)
Calcium (mg)	1000	281.5	328.9	296.1	517.6
		(229.2)	(261.1)	(236.9)	(387.9)
Iron (mg)	8	10.04	14.59	13.20	23.22
		(5.859)	(7.474)	(7.049)	(11.80)
Zinc (mg)	11	12.58	10.85	9.763	17.33
		(6.597)	(5.434)	(4.967)	(8.832)

Specifically, when we compare average individual-level nutrient availability constructed via our nutrient-specific scale with that via a calorie-based scale (columns 2 and 3 of Table 3, respectively), we find that, on average, estimated availability is greater for proteins, vitamins A, C, B1, B2, B3, B9, B12, and zinc when calculated using the nutrient-specific scale. This indicates that on average a calorie-based scale will underestimate the availability of these nutrients within a household. For the rest of the nutrients, the average availability is greater when using the calorie-based scale, indicating this scale will underestimate their availability, on average. Comparing the nutrient-specific scale with a per capita scale, the per capita scale underestimates nutrient availability for most nutrients with the exception of calcium and iron. Finally, average nutrient availability estimated via the OECD equivalency scale substantially overestimates individual-level nutrient-availability for all nutrients examined.

Table 4[3] reports the average difference between nutrient availability based on the nutrient-specific scales and the other three scales and tests whether or not those differences are statistically different from zero. All reported average

[2] The figures in parenthesis are the standard deviations of the daily nutrient availability per household male equivalent based on each of the three adult equivalency scales.

[3] Table 4 shows missing means for the difference between availabilities calculated through per capita and nutrient-specific adult-equivalent scales for carbohydrates, and vitamin D. This is because according to the Institute of Medicine's guidelines, the requirements for these nutrients do not change with age and sex. The missing values in Table 5 and 6 are also because of the same reason.

differences are statistically significant at one percent level of significance. The only exception is that there is no difference between the nutrient-specific and the per capita scales when estimating household nutrient-availability in carbohydrates or vitamin D. This is because daily recommendations for these two nutrients are the same across all the demographic cohorts. Some of the average differences reported in Table 4 are quite substantial as a proportion of the daily recommendation. For example, average differences in estimated protein availability range from approximately 14% to 40% of the daily recommendation. Average estimated differences in Vitamin B9 range from 2% to 82% of the daily recommendation.

Table 4. Difference in means between nutrient-specific and other nutrient availabilities.

Variables	Calorie-Based	Per Capita	OECD
Carbohydrates	-36.64***	-	-259.8***
Proteins	8.853***	14.03***	-22.65***
Vitamin A	15.74***	26.80***	-49.45***
Vitamin C	12.16***	16.85***	-18.06***
Vitamin D	-0.0403***	-	-0.305***
Vitamin B1	0.117***	0.320***	-1.139***
Vitamin B2	0.0757***	0.151***	-0.371***
Vitamin B3	1.619***	3.753***	-11.45***
Vitamin B6	-0.0446***	0.174***	-1.378***
Vitamin B9	9.947***	60.66***	-328.5***
Vitamin B12	0.0106***	0.107***	-0.552***
Calcium	-47.39***	-14.62***	-236.1***
Iron	-4.550***	-3.156***	-13.18***
Zinc	1.736***	2.819***	-4.746***

Note: *** p<0.01.

To further illustrate this point, we take an example representative household from the NLSS III dataset, comprising of two males, aged 48 and 15 years old, and four females aged 67, 43, 12, and 4 years old. These ages represent the average age of husbands, wives, sons, daughters, and elderly individuals in the NLSS III dataset. Furthermore, we add a 4-year-old female to our representative household to see the effect of additional children on the calculated individual-level nutrient availability. We also calculate the average nutrient availability per household for every nutrient in the dataset while assuming that if these amounts of every nutrient were available to the representative household described above, how the use of calorie-based, per capita, and OECD scales will compare with the use of nutrient-specific scale. Table 5 shows these results where a negative number means that the scale in question overestimates the individual-level availability for that specific nutrient while a positive number suggests underestimation of the same. For example, the calorie-based scale underestimates the individual-level availability of proteins while overestimating the individual-level availability of calcium for the representative household in comparison with the nutrient-specific scale.

The results in Table 5 clearly show that the use of a calorie-based, per capita, or OECD adult-equivalence scale for all macro- and micronutrients will either underestimate or overestimate the true nutrient availabilities for the representative household in the sample. Therefore, the nutrient-specific adult-equivalent scales developed in this paper provide a better way of converting the food purchases or consumption data from household surveys into reliable measures of individual-level nutrient availabilities, potentially reducing the measurement error in future studies.

Table 5. Over- and underestimation of individual-level nutrient availability from different adult-equivalent scales for a representative household.

Variables	Calorie-Based	Per Capita	OECD
Carbohydrates (grams)	-30.4	-	-357.41
Proteins (grams)	11.08	15.34	-34.76
Vitamin A (micrograms)	18.56	27.27	-75.07
Vitamin C (milligrams)	15.35	19.37	-27.81
Vitamin D (micrograms)	-0.04	-	-0.41
Vitamin B1 (milligrams)	0.16	0.33	-1.66
Vitamin B2 (milligrams)	0.09	0.15	-0.56
Vitamin B3 (milligrams)	2.13	3.9	-16.94
Vitamin B6 (milligrams)	0.05	0.23	-1.91
Vitamin B9 (micrograms)	25.53	70.21	-455.2
Vitamin B12 (micrograms)	0.04	0.12	-0.77
Calcium milligrams)	-58.48	-32.99	-332.73
Iron (milligrams)	-4.21	-3.05	-16.75
Zinc (milligrams)	1.96	2.84	-7.53

3.1. Nutrient-Income Elasticities from Different Scales

As a robustness check for the finding that individual-level nutrient availabilities obtained from different adult-equivalence scales are significantly different from each other, we calculated the nutrient-income elasticities for all macro- and micronutrients using Ordinary Least Squares (OLS). In our econometric model comprising of separate regression equations, the dependent variables are the natural log of the individual-level nutrient availabilities for each macro- and micronutrient calculated using the nutrient-specific, calorie-based, per capita, and OECD adult-equivalence scales. The main variable of interest is the natural log of per capita household income, while the control variables include educational dummy variables for the household head, the number of male and female children (less than 17 years old) in the household, the number of male and female adults in the household, and dummy variables indicating whether the household is Brahmin caste (upper caste), lives in an urban center, and whether the household head is male. Community controls consist of spatial features including distance to market and regional dummies. We also control for community fixed effects. For further discussion on the variables used, refer to Ali, et al. [6]. Table 6 shows these results.

Table 6. Nutrient-income elasticities for macro- and micronutrients from different scales.

Nutrient-income elasticities	(1)	(2)	(3)	(4)	(5)
	Nutrient-Specific	Calorie-Based	Per Capita	OECD	Chi-Squared
Carbohydrates	0.204***	0.198***	-	0.121***	47.80***
	(0.0148)	(0.0147)	-	(0.0157)	
Proteins	0.318***	0.350***	0.356***	0.274***	226.46***
	(0.0142)	(0.0135)	(0.0134)	(0.0147)	
Vitamin A	1.061***	1.082***	1.085***	1.015***	330.76***
	(0.0387)	(0.0382)	(0.0378)	(0.0399)	
Vitamin C	0.617***	0.655***	0.659***	0.585***	209.21***
	(0.0296)	(0.0288)	(0.0286)	(0.0301)	
Vitamin D	0.558***	0.579***	-	0.626***	423.49***
	(0.0210)	(0.0218)	-	(0.0260)	
Vitamin B1	0.229***	0.247***	0.251***	0.180***	128.91***
	(0.0121)	(0.0117)	(0.0117)	(0.0131)	
Vitamin B2	0.425***	0.438***	0.435***	0.401***	552.88***
	(0.0128)	(0.0122)	(0.0119)	(0.0140)	
Vitamin B3	0.216***	0.236***	0.242***	0.160***	86.70***
	(0.0140)	(0.0136)	(0.0136)	(0.0147)	
Vitamin B6	0.141***	0.180***	0.185***	0.110***	69.14***
	(0.0135)	(0.0129)	(0.0130)	(0.0141)	
Vitamin B9	0.618***	0.638***	0.644***	0.561***	238.45***
	(0.0250)	(0.0247)	(0.0246)	(0.0257)	
Vitamin B12	0.789***	0.800***	0.781***	0.829***	609.62***
	(0.0241)	(0.0238)	(0.0230)	(0.0275)	
Calcium	0.544***	0.532***	0.538***	0.455***	242.45***
	(0.0215)	(0.0215)	(0.0214)	(0.0224)	
Iron	0.347***	0.318***	0.323***	0.243***	110.67***
	(0.0147)	(0.0145)	(0.0145)	(0.0156)	
Zinc	0.214***	0.235***	0.241***	0.161***	99.59***
	(0.0142)	(0.0136)	(0.0136)	(0.0147)	
Observations	4,425	4,425	4,425	4,425	4,425

Note: Robust standard errors in parentheses.
*** p<0.01.

Columns (1) to (4) of Table 6 show that using a nutrient-specific in comparison to calorie-based, per-capita, or OECD adult-equivalence scale results in changes in estimated nutrient-income elasticities. Column (5) of Table 6 also shows that the null hypothesis of equality of the coefficients in each row was rejected at the 1% level of significance. Therefore, we can conclude that the choice of adult-equivalence scale in the calculation of individual-level nutrient availability might matter when it comes to the estimation of nutrient-income elasticities. Further analysis is needed to see if the choice of adult-equivalence scale in the calculation of nutrient availabilities makes a difference in other kinds of studies involving their use.

4. Conclusion

Household surveys usually contain data on food purchases or food consumption that have been used widely used to construct of calorie and nutrient availability in a household. While this approach provides a good measure of household-level nutrient availability, it is problematic to translate this measure into individual-level nutrient availability when nutrient requirements differ depending on demographic cohorts and households differ in their demographic make-up. To address this problem, adult equivalency scales are often employed in which household nutrient availability is divided by the number of adult equivalents in the household. Different equivalency scales, such as per capita, the OECD, or calorie-based scales, result in different estimated numbers of adult equivalents. While each of these scales are appropriate for certain situations they cannot be universally applied to every macro- and micronutrient. For example, when individual-level calorie availability is calculated using a calorie-based scale, none of them provide accurate estimates of household nutrient availability per adult male equivalent for other important macro- and micronutrients.

In this paper, we propose a set of adult-equivalent scales for macro- (carbohydrates and proteins) and micronutrients (vitamins and minerals) based on the specific daily intake requirement for each nutrient across different demographic cohorts. These nutrient-specific scales can be used in future research relying on household food expenditure/availability surveys to arrive at individual-level nutrient availability measures. Using this more accurate scale for nutrient-specific adult equivalents will reduce measurement error in these studies.

We find that other commonly used adult-equivalent scales can result in drastically different estimates of nutrient-availability per adult equivalent. Moreover, they can misrepresent whether a household has enough of a nutrient available to meet its needs or if it is actually deficient in that nutrient. Therefore, it is necessary to use equivalency scales that are appropriate for the nutrient of interest and the demographic make-up of the household.

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