# A Critical Evaluation of Recent Attempts at Assessing World Hunger

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This paper attempts to provide some perspective on two of the most recent assessments of the world food situation and to indicate some of the difficulties involved in quantifying the extent of malnutrition. The conclusions and methodologies of the major postwar studies of the world food situation and attempts at measuring the magnitude of malnutrition are outlined in Table 1. As can be seen from the accompanying Figure 1, on a global basis, the number of persons identified by those studies as being nutritionally deficient, in terms of either calorie or protein/calorie deficits, ranges from nearly two billion persons to fewer than one-half billion. Most of the studies measure calorie deficits. Although the importance of protein deficits is recognized, calorie deficits have again come to be emphasized since, in the light of the most recent recommendations regarding the coverage of protein needs, it seems improbable that a dietary intake sufficient to cover energy requirements will be insufficient to meet protein requirements, except for some particular population sub-groups. (FAO, p. 47).

The two studies which are evaluated here - Malnutrition and Poverty, by Reutlinger and Selowsky of the World Bank and The Fourth World Food Survey, conducted by FAO, show estimates of the malnourished population of the world which differ by more than six hundred million people. The possible reasons for this wide discrepancy are discussed here and the methodologies by which the estimates were generated critically appraised.

TABLE 1. CONCLUSIONS OF MAJOR EARLY POSTWAR STUDIES OF THE WORLD FOOD SITUATION AND SELECTED RECENT PRONOUNCEMENTS

| Year Published | Conclusions | Methodology |
|---|---|---|
| 1946 | FAO - "World Food Survey"[a/]<br>"In areas containing over half the world's population [prewar] food supplies . . . were sufficient to furnish an average of less than 2250 calories . . . an average of more than 2750 calories . . . were available in areas [with] less than a third of the world's population . . . the remaining areas . . . . had food supplies between these . . . levels" (pp. 6-7). | National food balance sheet availabilities minus 15 percent wastage allowance compared with 2,600 Kcal./caput/day allowance (p. 11). |
| 1952 | FAO - "Second World Food Survey"[b/]<br>"The average food supply per person over large areas of the world, five years after war was over, was still lower than before the war" (p. 2). "59.5 per cent of population [lives in countries] with under 2200 [Calories]" (p. 11). | National food balance sheet availabilities minus 15 percent wastage allowance compared with regional allowances (p. 22):<br>Far East - 2230-2300 Kcal.<br>Africa - 2400-2430 Kcal.<br>Latin America - 2440-2600 Kcal. |
| 1961 | USDA - "World Food Budget, 1962 and 1966"[c/]<br>"Diets are . . . adequate in the 30 industrialized nations . . . [where] more than 900 million people live . . . For most of the 70 less-developed countries . . . diets are nutritionally inadequate, with shortages of proteins, fat, and calories. These countries contain over 1.9 billion people. In most of them, population is growing rapidly, malnutrition is widespread and persistent, and there is no likelihood that the food problem soon will be solved" (p. 5). | Almost identical to "Second World Food Survey." |
| 1963 | FAO - "Third World Food Survey"[d/]<br>[As of 1957-59, national food balance sheets and extrapolation of a limited number of budget surveys imply:] "as a very conservative estimate some 20% of the people in the underdeveloped areas are undernourished and 60% are malnourished. Experience shows that the majority of the undernourished are also malnourished. It is believed therefore . . . some 60% of the people in the underdeveloped areas comprising some two thirds of the world's population suffer from undernourishment or malnourishment or both." [Since some people in developed countries don't eat well,], "up to half of the peoples of the world are hungry or malnourished" (p. 51). | National food balance sheet availabilities with distribution around mean inferred from a few surveys in India and elsewhere compared after allowance for wastage with requirements calculated according to the 1957 FAO[e/] system. |
| 1964 | USDA - "World Food Budget, 1970"[f/]<br>"Two-thirds of the world's people live in countries with nutritionally inadequate national average diets . . . The basic problem of the diet-deficit countries is one of productivity. The people cannot produce enough food to feed themselves or produce enough other products to afford to buy the food they require. Food production has barely been able to keep ahead of population growth, much less provide for the expanded demand resulting from some improvement in per capita income" (pp. iii-iv). | Little changed from "World Food Budget, 1962 and 1966" |
| | In 1971 an FAO/WHO Expert Panel reassessed energy and protein "requirements" and dropped the protein figure for adults by about one third.[g/] | |
| 1973 | FAO - "Food Balance Sheets and World Food Supplies"[h/]<br>[As of 1964-66, most national balance sheets] "Suggest a surplus of protein availability." [However, other evidence "suggests a very uneven distribution of protein supplies . . . aggravated by seasonal imbalances . . . Furthermore, wherever calories are in short supply, proteins are diverted from their primary function of providing for growth and maintenance of tissues to the supply of energy for other vital function. This explains the widespread incidence of protein/calorie malnutrition in spite of the apparent excess of protein supplies" (p. 19). | |

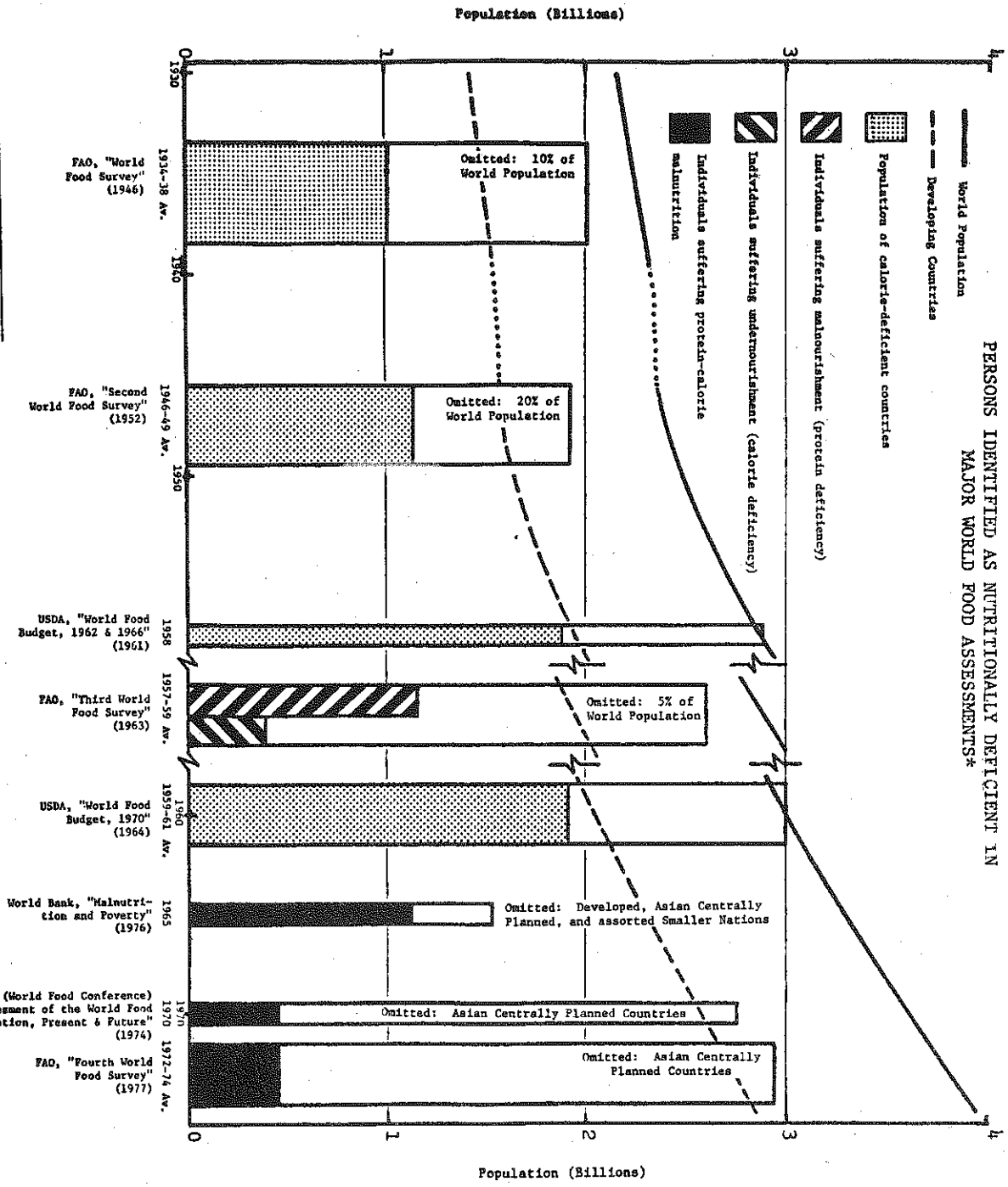
| Year Published | Conclusions | Methodology |
|---|---|---|
| 1974 | UN World Food Conference - "Assessment of The World Food Situation, Present and Future"[i/]<br>"Taking a conservative view, it would appear that out of 97 developing countries, 61 had a deficit in food energy supplies in 1970 . . . Altogether in the developing world . . . 460 million people [are affected]; a less conservative definition might give a much higher figure" (p.5). "The poorer segments of the population, and within these segments, the children in particular, will bear the brunt of an insufficient food supply" (p. 64). | National average availabilities with distribution by income inferred from a limited number of surveys compared with energy cost of maintenance (1.5 x basal metabolic rate) minus 20 percent "It is the use of this very conservative level that leads to the estimate of over 400 million individuals . . ." (p. 72). |
| 1976 | World Bank (Reutlinger and Selowsky) - "Malnutrition and Poverty"[j/]<br>[As of] "the mid-1960s, it is estimated that 56 percent of the population in developing countries (some 290 million people) had calorie-deficient diets in excess of 250 calories a day. Another 19 percent (some 290 million people) had deficits of less than 250 calories a day" (p. 2). | Regional calorie deficits, which were added for a global deficit, were determined by taking the difference between per capita calorie intake for a given income group within a region and uniform (for all countries within a region) per capita calorie requirement. Calorie consumption by income groups was derived on the basis of a calorie-income elasticity estimated from an equation expressing the relationship between average per capita income and average per capita calorie intake for all countries within a region. |
| 1977 | FAO - "Fourth World Food Survey"[k/]<br>"The evidence . . . indicates that the overall supplies of food . . . could be adequate to meet nutritional needs of the world's population if the distribution . . . were ideal . . . It is clear that the malnourished are found particularly . . . in the poorest section of urban population and in rural areas where adverse ecological conditions, land tenure systems and other economic factors lead to . . . large landless and unemployed groups . . .<br><br>Within these groups, it is the pre-school children, younger women and school-age children who suffer most" (pp. 45-46).<br><br>"Calculations indicate an order of magnitude of about 400 million as a conservative estimate of the number of persons undernourished in the developing countries, excluding the Asian centrally planned economies" (p. 54). | Country calorie deficits determined by distributing calorie intake by income group within a country, using a Beta distribution to allow for a skewed distribution of calorie intake, and comparing<br><br>calorie intake against a critical energy maintenance level (1.2 basal metabolic rate). Calorie intakes were derived using an estimated calorie-income elasticity similar to that used by Reutlinger and Selowsky. |

Sources:
- a/ FAO, World Food Survey (Washington, 5 July 1946).
- b/ FAO, Second World Food Survey (Rome, November 1952)
- c/ USDA, ERS, The World Food Budget, 1962 and 1966 (For. Agr. Econ. Report 4, October 1961).
- d/ FAO, Third World Food Survey (Freedom from Hunger Basic Study 11, 1963).
- e/ FAO, Calorie Requirements (Nutritional Studies 15, 1957)
- f/ USDA, ERS, The World Food Budget, 1970 (For. Agr. Econ. Report 19, October 1964).
- g/ FAO, Energy and Protein Requirements (Nutrition Meetings Report Series 52, 1973).
- h/ "Food Balance Sheets and World Food Supplies," (FAO) Nutrition Newsletter, April-June 1973.
- i/ UN, World Food Conference, Assessment of the World Food Situation, Present and Future (Item 8 of the Provisional Agenda, November 1974).
- j/ Shlomo Reutlinger and Marcelo Selowsky, Malnutrition and Poverty (World Bank Staff Occasional Paper 23, 1976).
- k/ FAO, The Fourth World Food Survey (Statistics Series 11, 1977).

**Source: (Poleman)**

Figure 1

PERSONS IDENTIFIED AS NUTRITIONALLY DEFICIENT IN MAJOR WORLD FOOD ASSESSMENTS*




Source: (Poleman)

*Nutritional data from the food assessments cited in Table ; population estimates from U.N., Demographic Yearbook, various issues.

Both studies attempt to determine the distribution of calorie intake by income group and to calculate calorie deficits by income groups. By doing so and by focussing on the nutritional inadequacies of particular income groups, target groups may be more adequately identified and policies designed to improve nutrition of those groups. However, data limitations have usually prevented comprehensive analysis of the relationship between calorie intake and income and estimating on a global basis the magnitude of malnutrition.

Firstly, income and consumption surveys are not available for many of the countries in which nutritional inadequacies are likely to be most severe (i.e. the LDC's). Secondly, even where they do exist, the data most often refer to expenditure, which is used as a proxy for income, and to expenditures on food, used as a proxy for food quantities and thereby for calorie availability, which is a proxy for calorie intake. Because expenditure data are used in consumption functions in which the true relationship is with income, rather than expenditure, results based on this incorrectly specified function may be inconsistent. Only if total expenditures are grouped by income level can consistent estimates of the consumption functions be obtained (Zarembka, p. 199). Using expenditures on food for calorie availability and intake figures does not take into account consumption of higher quality foods at higher income levels which means that true calorie availabilities may be understated for low income levels and overstated for high income levels. This also means that true calorie availibilities will be understated for rural households in countries with a large subsistence sector, where available food supplies may actually be at a higher level than would be reflected in available food expenditure data. An additional problem is presented by recent findings which indicate that calorie intake varies much more than calorie, or energy, expenditures, both across

individuals and for the same individual over time (Sukhatme), which brings into question the importance of using calorie intake as a means for assessing the nature and magnitude of malnutrition.

It is in the context of these data limitations that the methodologies used in the World Bank and FAO studies to estimate the magnitude of the malnourished population must be evaluated. Due to lack of country income and consumption surveys, both studies used food balance sheets to obtain apparent average food availabilities, and implicitly from that, calorie availabilities and intakes. The use of food balance sheets for such purposes does mean that true calorie availabilities may be understated because production is likely to be understated, but here we direct discussion towards possible biases which may have resulted from the particular methodologies used for obtaining estimates of the magnitude of the malnourished population. (Also not directly discussed here is the use of different calorie requirement levels in the studies under review, although it is recognized that the difference in these levels may be an important reason for the difference in the calorie deficits obtained by the studies.)

In the World Bank Study by Reutlinger and Selowsky, the total calorie deficit of a region is determined by taking the difference between per capita calorie intake, or consumption, for a given income group within a region and a uniform (for all countries within a region) per capita calorie requirement, the population shares of each income group being used to obtain the calorie deficit of each income group within the region. Although using a uniform per capita calorie requirement for all countries within a region may be questionable, it is the methodology by which the per capita calorie consumptions by income group were obtained which is of concern here.

To obtain these figures, Reutlinger and Selowsky regress country averages of per capita calorie consumption on country averages of per capita income, across all countries within a region, i.e.: $C_j = a + b \ln X_j + \varepsilon_j$ (1).

where $C_j$ and $X_j$ are country averages of per capita calorie consumption and income. From the estimated equation 1), $\hat{b}$ was obtained and, $\mu$, the income elasticity of calorie consumption derived at a region's observed level of average per capita calorie consumption, $C_o$, where $\mu = \hat{b}/C_o$. For example, if $\hat{b} = 417$, and $C_o = 2{,}471$, $\mu = .168$. On the basis of the $\hat{b}$ and $\mu$ obtained, Reutlinger and Selowsky determined the range of the $\mu$ to be between .15 and .30. The plausibility of this range was tested in various ways, for example, on the basis of the implied income levels at feasible calorie consumption levels.

These estimates of $\mu$ then were used to generate calorie consumption figures over a distribution of incomes (ranging from U.S. $25 to U.S. $3,000) within a region[1/], and the calorie consumption figures so generated were used in the calculation of the calorie deficits. Given the differences between Reutlinger and Selowsky's and the FAO's estimates of the calorie deficit population and given the dependence of Reutlinger and Selowsky's calculated deficits on their estimated calorie-income elasticity, $\mu$, it is important to determine the possibility of $\mu$ being upward biased; $\mu$ is upward biased if $\hat{b}$ is upward biased since $\mu = \hat{b}/c$. If the value of $\mu$ was reduced from .15, the lowest level of $\mu$ considered by Reutlinger and Selowsky, to .10, estimated calorie deficits at the lowest income level, (U.S. $25), would be reduced by 22% for Asia, by 28% for the Middle East, and by 23% for Africa. Since the percentage share of the lowest income population in these three regions are, respectively, 13%, 20% and 30%, the total calorie deficit for each of the regions would have been substantially reduced by using a calorie-income elasticity of .10 rather than a possibly upward biased elasticity of .15.

To determine the true effect of income on calorie consumption, as it is distributed across income groups, and thus to determine the unbiased calorie-

income elasticity, the model which should be estimated is one in which per capita calorie consumption varies over a distribution of per capita incomes both within and between countries, i.e.:

$$C_{ij} = a + b \ln X_{ij} + \varepsilon_{ij} \qquad 2)$$

where $C_{ij}$ is per capita calorie consumption of income group i in country j; $X_{ij}$ is per capita income of group i in country j and $\varepsilon_{ij} = \varepsilon_i + \varepsilon_j$, where $\varepsilon_i$ is the residual associated with variations in calorie consumption <u>within</u> countries and $\varepsilon_j$ the residual associated with variations in calorie consumption <u>between</u> countries.

Reutlinger and Selowsky's estimate of b, $\hat{b}$, is a consistent estimator of the true b in equation 2) only if $\text{Cov}(\varepsilon_i X_j) = 0$ and $\text{Cov}(\varepsilon_j X_j) = 0$ since:

$$\hat{b} = \frac{\text{Cov}(C_{ij}, X_j)}{\text{Var}(X_j)} = \frac{\text{Cov}(a + b X_{ij} + \varepsilon_i + \varepsilon_j, X_j)}{\text{Var}(X_j)}$$

or,

$$\text{plim } \hat{b} = b \frac{\text{Cov}(\varepsilon_i X_j) + \text{Cov}(\varepsilon_j X_j) + \text{Var}(X_j)}{\text{Var}(X_j)}$$

Thus the $\hat{b}$ is upward biased if either $\text{Cov}(\varepsilon_j X_j)$ or $\text{Cov}(\varepsilon_i X_j) > 0$. One source of an upward bias of $\hat{b}$ would be if the estimated equation 1) omits some variables which are positively correlated with per capita income.

Although Reutlinger and Selowsky (p. 14-15) discuss the possibilities of $Cov(\varepsilon_j X_j) > 0$, that is, the possibilities of a positive correlation between per capita income and the residuals associated with variations in per capita calorie consumption between countries, they conclude that since it is just as likely that $Cov(\varepsilon_j X_j) < 0$ the net bias of $\hat{b}$ cannot be determined. However, they do not discuss the posibility of $Cov(\varepsilon_i X_j) > 0$, i.e. a positive correlation between per capita income and the residuals associated with variations in per capita calorie consumption within countries. One of the most likely sources of such a positive correlation is the omission of age distribution variables, positively correlated with income levels, in the equation 1) estimated by Reutlinger and Selowsky. The age composition of higher income families with fewer children and more adults (for example, servants) means that calorie consumption for these groups will be higher than for the low income groups which have greater numbers of children and perhaps of old persons also. Another source might be the consumption of higher quality foods at higher income levels.

In the light of the possible upward bias of the $\hat{b}$ and $\mu$ estimated by Reutlinger and Selowsky and a possible over-estimate of the calorie-deficit population, it is interesting to examine the methodology used in the FAO study, which arrived at an estimate of the calorie-deficit population less than half that arrived at by Reutlinger and Selowsky. In the FAO study, the same equation, i.e.:

$$C = a + b \ln X \qquad 3)$$

was used to determine the relationship between per capita calorie consumption and per capita income and the probability density function of a Beta distribution was used to fit calorie consumptions to the distribution of income within

each country. That is, having estimated b in equation 3), the standard deviation of the logarithm of income can be multiplied by this estimated b to get the standard deviation of calorie consumption and these standard deviations used in the Beta distribution function to get a distribution of calorie consumption over income groups.

Now, if the b from equation 3) is upward biased, so too will be the standard deviation of calorie consumption derived from that equation. If these standard deviations are too high, because of the properties of the Beta distribution function (whereby the skewness of the function is likely to be displaced to the left, i.e. calorie consumption becomes higher for the lowest income levels, as the standard deviations increase)[2/], the lowest income levels are likely to have distributed to them a higher calorie consumption and thereby a lower calorie deficit. Thus, if the estimated b's of equation 1) and 3), and thereby the derived calorie income elasticities, are upward biased, the calorie deficits estimated by Reutlinger and Selowsky's methodology would tend to be too high and those estimated by FAO's methodology would tend to too low. The difference in their estimated calorie deficits could then be attributed to that upward bias. Without knowing the precise figures for calorie-income elasticities and for the standard deviations used by FAO, which are not given in the Survey, it is impossible to determine by how much their estimates could change given the use of a different set of numbers.

In conclusion, it can be said that estimating the magnitude of the world population that is deficit in calories and is malnourished in a consistent and unbiased way is not an easy task, given the severe data limitations that appear as an obstacle to doing so. It is also a task which should be undertaken with

great care given the sensitivity of the results to certain parameters, such as calorie-income elasticities. This limited review suggests that any biases that might result from the data and the methodology used should be clarified and taken into account in a more systematic way. However, in view of the importance of determining the numbers of malnourished persons, more efforts towards doing so should be forthcoming, efforts which could build upon the methodologies and results of the two important studies reviewed here.

## Footnotes

1/ The log of per capita income, lnX, was used in the equation $C = a + b \ln X$, to generate the per capita calorie consumption, C, of each income group. The b used here was first calculated so that it was consistent with an elasticity of .15 (or .30) at the per capita calorie requirement, $C_r$, for the region (knowing $C_r$ and $\mu$, b was found using the relationship: $\mu = b/C_r$).

2/ The probability density function of the form of the Beta distribution used in the FAO survey is:

$$f(y) = \frac{y^{p-1}(b-y)^{q-1}}{p + q - 1 \quad B(p,q)} \qquad 0 < y < b;\ p,q > 0$$

where: y = income and f(y) = calorie consumption, the range of b is assumed to be known and:

$$p = \frac{m_1(m_1 - \frac{m_2}{b})}{\sigma^2} \qquad q = \frac{(b-m_1)\ (m_1 - \frac{m_2}{b})}{\sigma^2}$$

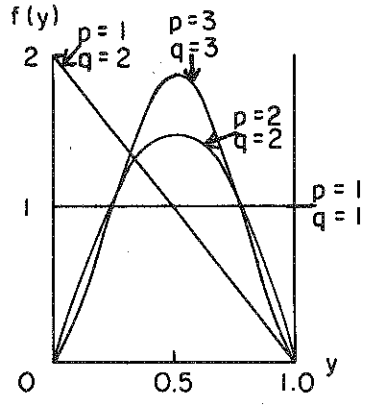
where: $\sigma^2 = m_2 - m_1^2$ is the variance of the distribution

$m_1$ = the first moment about the origin

$m_2$ = the second moment about the origin, the standard deviation

As $m_2$, or the standard deviation of calorie consumption, increases, p and q decrease and as p and q decrease, f(y) is likely to become skewed to the left. For example, this may be shown by graphing f(y) for values of p, q = 1, for p = 1, q = 2, for p, q = 2 and for p, q = 3, for the probability density function of the standard form of the Beta distribution (Johnson and Kotz):

$$f(y) = \frac{y^{p-1}\ (1 - y)^{q-1}}{B(p,q)} \qquad 0 \leq y \leq 1;\ p > 0,\ q > 0$$




As can be seen, as p and q increase, f(y) or calorie consumption will increase for the lowest income groups.

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