Factors Affecting Contaminant Concentrations in Foods

- Food source (e.g., homegrown, locally grown by a small producer, domestically grown by a mass producer and imported)
- Former or current application of pesticides (US NRC, 1993).
- The form in which food is consumed (e.g., raw apple, apple sauce, apple juice) can be very different in different subpopulations (e.g., adults, elderly or young children).

WHO HUMAN EXPOSURE ASSESSMENT
Personal Dietary Exposure Monitoring

- Best done by collection of duplicate portion samples.
- Duplicate portion samples are meals collected as prepared by members of the study population.
- This allows contaminants in food to be directly measured:
  1. Food samples are those actually consumed, rather than samples of unprepared, individual food items.
  2. Includes all methods by which food is prepared for consumption (e.g., washed, cooked, or commercially processed).
  3. Some pollutants can be generated during cooking, for example, benzo[a]pyrene (Waldman et al., 1991a) Thus, residue levels measured in duplicate portion samples are likely to more accurately reflect personal dietary ingestion exposures than raw agricultural commodities.
  4. Composite samples, taken over some time (t) provide an integrated measure of dietary exposure and provide an efficient means for characterizing total dietary exposures.
Examples of Important Differences in Exposure—Seen Only if Using Direct Measurement Techniques

- Malathion concentrations were found to decrease by 99% when raw tomatoes were processed into canned tomatoes (Elkins, 1989).

- Concentrations of ethylenethioureia, a carcinogenic degradation product of maneb (manganese ethylene bisdithiocarbamate), rose 94% when turnip greens were washed, blanched, frozen and subsequently sautéed (Elkins, 1989; Houeto et al., 1995).
A Major Limitation of Duplicate Portion Studies

- In duplicate portion studies, participants may not provide equal portions of expensive or well-liked foods, leading to underestimation of intake, exposure and thus risk.
- An example is a family sitting down to a swordfish dinner,
- Analytical chemistry costs associated with this degree of temporal resolution may be prohibitive.
- Require a high level of effort from study participants, and the complex food matrices may present analytical chemistry challenges.

WHO HUMAN EXPOSURE ASSESSMENT
Market basket or total diet surveys

• Market basket surveys use food chemical concentrations measured in ready-to-eat foods prepared in the laboratory.
• This data is linked to model diets derived from food consumption data and standard recipe preparation for large populations, households or individuals.
• Initially the purpose of market basket surveys was to estimate background exposures of the population to pesticides residues and radioactive contaminants.
• Today's market basket emphasis has shifted from pesticides to toxic metals and more recently has included a variety of trace elements and organic contaminants.

WHO HUMAN EXPOSURE ASSESSMENT
Market Basket Example

• The US FDA Total Diet Study (US TDS) is a market basket survey based on heavy metal and pesticide data measured in samples of 234 different ready-to-eat food products selected to be representative of over 4000 foods common in the diet of residents in the USA, and the results of national food consumption surveys (Pennington, 1992).
Advantages of Market Basket Approach

• The main advantage of the total diet (market basket) approach for estimating exposure is the ability to monitor trends without burdening study participants.
• The total diet approach allows data from separate studies of food consumption and contaminant residues to be combined (e.g., Tomerlin et al., 1996).
• This approach also allows analytical chemistry resources to be directed to the foods that are most likely to yield the greatest exposure (e.g., the foods consumed in greatest amounts and foods that are likely to contain the highest residue concentrations).

WHO HUMAN EXPOSURE ASSESSMENT
Disadvantages of Market Basket Approach

• The analysis of food groups may be too expensive for some contaminants
• Analysis may not be feasible for other contaminants because:
  1. Analytical methods may not be sufficiently reliable.
  2. The limit of detection may be too high.
  3. The grouping of the foods (compositing) may decrease the likelihood of finding the source of the contaminant.
Indirect Method - Questionnaires

- Questionnaires can be structured to determine with some confidence the foods eaten and cooking methods used by study participants.
- Portion size can be difficult to describe or visualize—portion size cutouts can be used to aid in visualization of portion size.
- Burger used this method to approximate intake of river caught fish. Important to use a cooked fish portion cutout not a raw fillet image.