Transcending reductionism in nutrition research[1–4]

Ingrid Hoffmann

ABSTRACT The reductionist approach has traditionally been and continues today as the dominant approach in nutrition research. This means that parts of diet rather than the whole, or single food components rather than food habits, are studied. Even though much progress has been made with this approach, the relationship between diet and health is not yet fully understood. With the recognition about the whole being more than the sum of its parts, the limitations on the applicability of the reductionist approach, and the growing knowledge about parts of diet, another epistemological approach, such as holism, and new research strategies, such as transdisciplinarity, are needed to reveal more about the relationship between diet and health. *Am J Clin Nutr* 2003;78(suppl):514S–6S.

KEY WORDS Reductionist approach, holistic approach, diet, health, parts, whole

INTRODUCTION

The main goal of nutrition research is to identify optimal diets to promote health and prevent diseases. For this reason, during the past several decades, extensive research has been conducted concerning the relationship between diet and health. With advances in methodology and deeper insight, nutrition research looks more and more at details and, therefore, at more differentiated parts of diet as well as health.

The question arises whether the parts add up to the whole. In other words, does summing up detailed knowledge about individual constituents of diet reflect the overall effect of diet? Research on vegetarian diets may teach us a lesson about this: investigating the effect of single nutrients, especially those prone to deficiency (such as vitamin B-12), led to a different perspective of vegetarian diets than investigating the effect of diet as a whole. Thus, findings of lower vitamin B-12 blood concentrations in vegetarians than in omnivores (1) led to a more negative point of view than the more recent results documenting a lower mortality rate from ischemic heart disease as an effect of a vegetarian diet as a whole (2).

The traditional and dominating epistemological approach in nutrition research is reductionism. (Epistemology is a branch of philosophy that studies the nature, origin, and limits of human knowledge. It addresses questions such as what knowledge is, how it is obtained, and what makes it knowledge.) This is also the case for the relationship between diet and health. From the reductionist point of view, the objective of science is to reconstruct reality by its parts. The reductionist stance advocates an additive character of linear cause-effect constructs, meaning that the whole can be explained by the sum of its parts (3, 4).

In this context, diet as a whole is referred to as the food selection or food pattern of a person or population. Diet is generally reduced to food groups, food items, and food constituents (**Figure 1**). Health as a whole in this context is viewed as physical health. This may be reduced to multiple systems, their components, and biological markers.

In the past century, nutrition research has focused on individual dietary constituents and their relationship to specific biological markers (Figure 1). This means that nutrition research has been carried out with highest differentiation or reduction to the smallest event, while the final purpose of this research was to contribute to the knowledge on optimal diet, which is on the level of high integration or the whole. Not surprisingly, the past and ongoing research illustrates that the whole may not be obtained by solely investigating its parts and adding up this knowledge, but rather that the whole is more than the sum of the parts.

There are several reasons why dietary and health issues go beyond the reach of a reductionist epistemological foundation. One reason is that diet and health feature complex system characteristics. These include being composed of a large number of components, not being completely reducible to its parts, and exhibiting nonlinear interactions between components, response delays, and feedback loops (5). The complexity of diet may be exemplified by its composition. Diet consists of a mixture of foods, and those foods are composed of a multitude of chemicals. As a result of this, there are combinational effects, such as interactions, antagonisms, and synergisms, that explain a proportion of the whole not being encompassed by examining the parts (6).

Out of the array of dietary components and the factors relevant for the relationship between diet and health, only a limited number are usually included in research models. Others not included in the models may also contribute to the relationship between diet and health. These additional components and factors may be known but not evaluated, or it may not be possible to evaluate them. Also, there may still be unknown components in the diet or unknown factors in the studied relationship. Thus, the understanding of the relationship between diet and health may partly be limited because

[1] From the Institute of Nutritional Science, University of Giessen, Giessen, Germany.

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[3] Supported by the Eden Foundation, Bad Soden, Germany.

[4] Address reprint requests to I Hoffmann, Institute of Nutritional Science, University of Giessen, Wilhelmstrasse 20, D-35392 Giessen, Germany. E-mail: ingrid.hoffmann@ernaehrung.uni-giessen.de.

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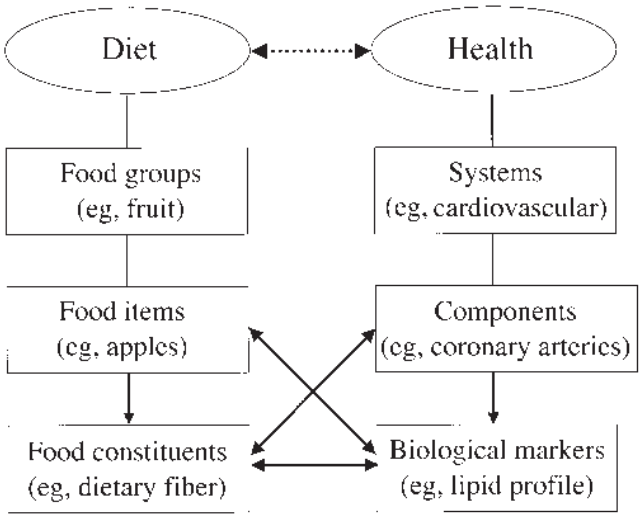

FIGURE 1. This represents the whole and the parts of diet and health. Starting from the top as whole, both diet and health may be reduced to parts (symbolized by the single rectangles and examples). The solid arrows indicate the usually studied relationships, and the dotted arrow indicates the relationship that should also be studied.

there may be too many relevant components and factors to be considered; their assessment may be difficult; or their effects, although relevant, may be too small to be statistically significant.

Methodological aspects may also contribute to the gap between parts and the whole. As examples, inter- and intrapersonal variations of diet may be named. Traditional methodology usually applies to linear cause-effect relationships. In complex systems, such as diet or health, multicausal nonlinear relationships (3) may exist in addition to linear cause-effect relationships.

Studying the parts with the reductionist approach allows the description of the interaction of a single nutrient with a single outcome and is essential for subsequently exploring the effect of the whole. However, just investigating the effect of parts or the combination of some parts may lead to formally accurate scientific assessments but still provide a very restricted and biased view of reality (7). Consequently, the reductionist approach fails to adequately describe the multiplicity of metabolic effects on the entire organism (8).

ANOTHER EPISTEMOLOGICAL APPROACH AND NEW RESEARCH STRATEGIES

With the understanding that the whole is more than the sum of its parts, the recognition that the applicability of the reductionist approach is limited, and the emergence of knowledge about parts of diet, another epistemological approach, and new research strategies are required for researching diet and health as a whole.

Holism is an epistemological approach dealing with complexity and aiming to overcome the limitations of the mechanistic concept of nature. Instead of focusing on parts and linear cause-effect relationships, holism focuses on the whole and circular causalities. In the holistic concept, the whole is not viewed as the sum of its parts or something additional to the parts. It is rather considered as the dynamic interaction of the parts in their synthesis. This implies that a system as a whole has features not found in any one of the parts (9).

For capturing diet as a whole—in addition to considering the holistic approach—several prerequisites need to be addressed. First, knowledge about parts is essential for an understanding of the whole. The reductionist approach has its place and is justified in the wider scope of holism (3). This means that investigating the relationship between diet and health on the level of dietary constituents is necessary. However, nutrition research should also include research on foods and food groups (10) and examination of dietary patterns or different dietary regimens, such as vegetarian diets. Because research on the level of diet automatically embraces the effect of all food components, foods, food groups, and their combinational effects, it will result in a more comprehensive and new understanding of the relationship between diet and health.

Second, to gather more detailed information and to assess many factors influencing the relationship between diet and health, sophisticated methodology is required. This applies to the study design, especially dietary assessments, and to statistical methods.

Third, there is a need for the development of more complex models that allow information combining and insight into the complexity of the whole with its interactions (eg, modeling complex systems). The American Society for Nutritional Sciences takes one step in this direction by encouraging scientists in the field of nutrition to integrate the knowledge from molecular events to metabolism and further to behavior (11).

Fourth, massive computing power is essential to integrate detailed information about the parts, the influencing factors, and nonlinear relationships and to model complex systems.

Fifth, because nutrition combines several sciences, in this field multidisciplinary and interdisciplinary research strategies have frequently been applied. Multidisciplinarity is restricted to one or a variety of disciplines operating without the integration of concepts, while interdisciplinarity enables a collaboration of several disciplines exchanging concepts, methodology, and so on. Integrating the sciences of nutrition with holistic thinking makes it possible to proceed to a transdisciplinary concept. For transdisciplinarity it is characteristic to transgress the boundaries between and beyond disciplines and institutions, such as between basic and applied research (12, 13).

With advances in epistemological approaches, in nutritional knowledge, in methodology, in computational tools, and in research strategies, we are now able to go beyond the research on parts to learn more about optimal nutrition. Therefore, let us transcend the condition summarized by Werner Kollath (14, page 11), "Much is known—unfortunately in different heads," and conclude: Many parts are known, let us now grasp for the whole.

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