The complex interaction of causing and resulting factors of overweight/obesity

Increasing the understanding of the problem and deducing requirements for prevention strategies

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Summary

NutriMod is a nutritional ecological modelling technique which has been used to develop a literature-based qualitative cause and effect model to identify the complex factors and events involved in overweight/obesity. This model has helped to visualise the many multicausal and multidimensional interacting factors influencing overweight/obesity and their consequences. The model identified two direct effects – energy balance and biological factors. All other factors had indirect effects through the process chain, leading to changes in energy balance. These process chains may lead to feedback effects and thus to vicious circles. This model furthers knowledge of the development of overweight/obesity by enhancing our insights into the process chains, feedback effects, multicausality and multidimensionality. It thus provides a good basis for the development of successful preventive measures.

Keywords: Nutritional ecology, nutritional ecological modelling technique, NutriMod, complexity, prevention, overweight/obesity, qualitative cause and effect model

Introduction

Overweight/obesity has developed into an international epidemic, with severe consequences [1, 2], even though numerous prevention projects have been and are being implemented [e.g. 3, 4]. One reason for the mediocre success may be that preventive measures do not adequately allow for the complexity of the problem [5]. In this context, the present study presents and investigates the complex process of overweight/obesity using **NutriMod, a nutrional ecological modelling technique**. A qualitative cause and effect model is used here to visualise the interactions between the factors and effects described in the literature. Examples are presented to demonstrate new insights into overweight/obesity and preventive measures which may be identified by the presentation and investigation of these complex events.

Developing the model: the NutriMod modelling technique

A qualitative cause and effect model was developed on the basis of the scientific literature, with the help of the nutritional ecological modelling technique (***Nutritional ecological Modelling***) (◆Figure 1) [6, 7]. The four dimensions of nutrition – health, society, environment and economics – were considered, in accordance with the **nutritional ecological approach** [8, 9]. Between March 2006 and February 2009, a search of the scientific literature was performed in numerous databases (e. g. Medline, Web of Science, Agricola, FSTA, EMBASE), using search terms such as overweight, obesity, causes and effects, together with search terms from the different dimensions of nutrition (e. g. for the
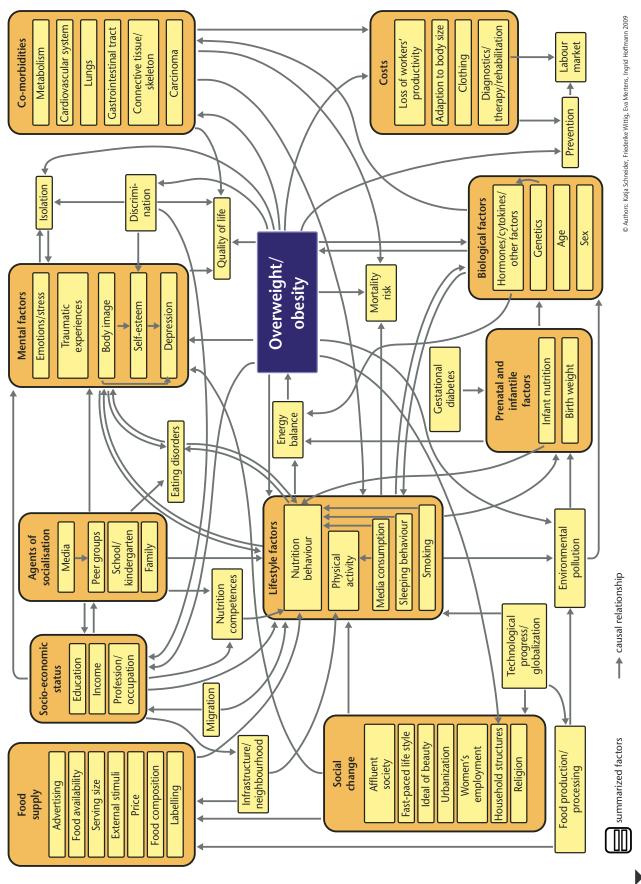
Fig. 1: **Qualitative Model of Causes and Effects of Overweigh/Obesity** [10]

Key elements shown in the figure:

Co-morbidities: Metabolism, Cardiovascular system, Lungs, Gastrointestinal tract, Connective tissue/skeleton, Carcinoma

Costs: Loss of workers' productivity, Adaption to body size, Clothing, Diagnostics/therapy/rehabilitation

Mental factors: Emotions/stress, Traumatic experiences, Body image, Self-esteem, Depression

Biological factors: Hormones/cytokines/other factors, Genetics, Age, Sex

Prenatal and infantile factors: Infant nutrition, Birth weight

Agents of socialisation: Media, Peer groups, School/kindergarten, Family

Socio-economic status: Education, Income, Profession/occupation

Lifestyle factors: Nutrition behaviour, Physical activity, Media consumption, Sleeping behaviour, Smoking

Food supply: Advertising, Food availability, Serving size, External stimuli, Price, Food composition, Labelling

Social change: Affluent society, Fast-paced life style, Ideal of beauty, Urbanization, Women's employment, Household structures, Religion

Other nodes: Isolation, Discrimination, Quality of life, Overweight/obesity, Mortality risk, Energy balance, Eating disorders, Nutrition competences, Environmental pollution, Technological progress/globalization, Infrastructure/neighbourhood, Migration, Food production/processing, Gestational diabetes, Prevention, Labour market

→ causal relationship

summarized factors

dimension economics: costs, advertising; for the dimension health: comorbidities, physical activity, genetics). The search was limited to modelling of the situation in western industrial countries. The influences on overweight/obesity described in the scientific literature are then specified as factors in the qualitative cause and effect model (◆ Figure 1). Terms in italics in this article are factors in the model. The factors are presented at a strongly aggregated level. Firstly, the listed factors often correspond to many more differentiated (sub)factors, which are not directly visible in the model, but which are implicit in it. For example, the factor *nutrition behaviour* includes the subfactors *food preferences*, *food selection* and *food preparation*. Secondly, many factors in the model are subsumed in a higher term. For example, the factors *media*, *peer groups*, *school/kindergarten* and *family* are subsumed in the higher term *agents of socialisation*. The factors are selected on the basis of their relevance to the theme of overweight/obesity and the currently available scientific literature. Thus this list does not claim to be complete. The arrows between the factors indicate causal connections, with the direction of action. For example, A → B means that A causes a change in B. The factors and interactions shown in the model are supported with the results from about 460 articles. In the electronic version of the model, the listed causal interactions and selected factors can be accessed in a hypertext structure, with specific descriptions, explanations and published examples (www.uni-giessen. de/fbr09/nutrecol/forsc_ adipositas.php [10]).

The complex causes and effects in overweight/obesity

Various aspects of the complex process of overweight/obesity will now be described in more detail and discussed on the basis of the model.

Factors affecting overweight/obesity

Overweight/obesity is influenced by numerous factors. A distinction must be made between direct and indirect factors. The cause and effect model shows only two factors which directly influence *overweight/obesity*: the *energy balance*, which results from the balance between energy intake and energy consumption, and *biological factors*, which subsume genetic predisposition (*genetics* in the model) and *hormones/cytokines/other factors*. All other factors described in the literature have an indirect effect on the development of *overweight/obesity* and almost always act through *energy balance*. For example, social change is an indirect factor, which can contribute to the development of *overweight/obesity* [1] through a positive *energy balance* from changes in *nutrition behaviour* and reduced *physical activity* [11]. This example shows that *overweight/obesity* can arise from a series of interacting factors, so-called "process chains". The model can be used to identify and understand these process chains.

Effects of overweight/obesity

Overweight/obesity is influenced by many different factors and has many different effects. The model shows that there are both direct effects and indirect effects acting through process chains. For example, *overweight/obesity* directly causes *costs* due to necessary adaptations in

vehicles [12] or operating tables [13] arising from changes in body measurements (in the model: *adaptation to body size*). Moreover, indirect *costs* arise from the diagnosis and therapy of comorbidities associated with *overweight/obesity*, such as changes in *metabolism* or the development of *carcinoma* [11].

Feedback loops

Process chains can close to form process cycles, which are known as feedback loops. These become clear if the causal connections between factors are depicted in a cause and effect model. For example, *overweight/obesity* can have the direct effect that affected individuals are at increased risk of suffering from *depression*, negative *body image* and low *self-esteem* [14]. These *mental factors* can lead to changes in *nutrition behaviour* and *physical activity*, causing a consistently positive *energy balance* [15], which may then enhance *overweight/obesity* [16], thus completing the vicious circle. Like most feedback loops in this model, this is a positive feedback, causing a vicious circle. As a result of feedback loops, effects can become factors and conversely. Thus, *mental factors* primarily have a direct effect on *overweight/obesity*, but, due to feedback loops, can have an indirect influence on its genesis or development. It is then not always possible to distinguish cause and effect in this complex process. Visualisation of the links can help us to portray factors which can be both cause and effect.

Multicausalities

Aside from process chains and feedback effects, the model aids the recognition of multicausality, i.e. when a single factor has several causes. For example, the model shows that *mental factors* are not

only influenced by *overweight/obesity* (as already mentioned), but also by numerous other factors, such as *social change*, *lifestyle factors*, *agents of socialisation*, etc..

Multidimensionality

In accordance with the nutritional ecological approach, factors affecting *overweight/obesity*, as well as their effects, are assigned to the four dimensions of nutrition (health, environment, economics and society). As a result of the visualisation in the cause and effect model, it is evident that factors of different dimensions may interact. This implies that process chains and feedback loops may act over more than a single dimension of nutrition, or be interdimensional. For example, *social change* (dimension: society) influences *lifestyle factors* (dimensions: society and health), which can then lead to *overweight/obesity* through changes in *energy balance*. Numerous *co-morbidities* (dimension: health) may develop as a consequence of *overweight/obesity*, leading to increased *costs* (dimension: economics).

Preventive measures must allow for the complexity of the process

A large proportion of current prevention projects have the objective of changing *nutritional behaviour* or *physical activity* and thus the *energy balance* [17].

Nevertheless, the cause and effect model of the complex process of *overweight/obesity* shows that a multitude of factors act on *nutrition behaviour* and *physical activity*, which are themselves influenced by other factors. This means that the causes of the genesis of *overweight/obesity* are frequently upstream to *nutrition behaviour* and *physical activity* and

act through **process chains**. Moreover, the cause and effect model includes **feedback loops**, converting effects to causes, with self-enhancing effects possibly leading to vicious circles. If a preventive measure is to be successful, it must therefore identify causes or possible approaches related to both direct and obvious factors, as well as indirect upstream factors along the process chains, as well as recognizing and considering feedback loops [see 18]. It is important to be aware of the **multicausal interactions** between the factors, as the influence of a preventive measure can counteract other influences within the complex process. Thus, both the factor directly affected by the preventive measure and other factors in the process chain may be

independently affected by other factors. If these indirect effects are neglected, the success of the measure may be attenuated or prevented. For example, a measure to increase schoolchildren's motivation to eat more fruit and vegetables (in the model: *food preferences* as subfactor of *nutrition behaviour*) would be unsuccessful if it neglected the current opinions and trends in the *peer group*. Alternatively, the motivation may be enhanced, but fail to change *food selection* (subfactor of *nutrition behaviour*), perhaps because fresh fruit and vegetables are not available at work or in the school (in the model: *availability*) or because the *price* is too high. It is therefore expedient to remember multicausality. As the process is **multidimensional**, dif-

ferent scientific disciplines and fields of practice must be involved in the **interdisciplinary** and **transdisciplinary** approaches used in planning preventive measures. The model can be supported by the visualisation of different factors in single dimensions, with identification of the relevant players [7, 8].

Conclusion

If preventive measures are to be successful, it is important to bear in mind how complex the process of overweight/obesity is. The multidimensional interactions between the factors and their effects must be better understood and process chains, feedback loops and multicausality must be recognised. The nutritional ecological modelling technique NutriMod was used to visualise the direct and indirect factors for overweight/obesity and their effects within complex and multidimensional interactions within a qualitative cause and effect model. This visualisation can enhance the understanding of the problem and thus provide a basis for the conception and implementation of effective preventive measures. The model makes it clear that there are two direct factors influencing the process chains, together with numerous indirect factors and feedback loops; these can all influence the genesis and development of overweight/obesity. Thus, the model can help to identify causes, which may have been neglected or be components of vicious circles. These may then provide possible approaches for novel preventive measures. The model also makes it clear which factors might impair the success of a measure, if its multicausal interactions are not recognised and considered. The model also portrays the multidimensionality of overweight/obesity and this can help to identify the relevant disci-

plines and areas of practice for inter- or transdisciplinary approaches and which can be incorporated into the conception of preventive measures. The present qualitative cause and effect model thus provides a good basis to make allowance for the complexity of the process of overweight/obesity and to develop appropriate preventive measures.

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