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

In order to demonstrate the complexity of overweight/obesity, a literature-based, qualitative cause-effect-model was developed applying nutrition-ecological modelling (NutriMod). By visualising many multicausal and multidimensional interrelated causes and effects of overweight/obesity, the model illustrates two factors directly causing overweight/obesity: energy balance and biological factors. All other factors influence overweight/obesity in particular via energy balance and thus indirectly via cause-effect chains. These cause-effect chains can join to feedback loops and thereby result in reinforcing vicious circles. The model increases the understanding of the complex interaction of overweight/obesity by gaining knowledge on cause-effect chains, feedback loops, multicausality and multidimensionality. Therefore, it serves as a good basis for the development of effective prevention measures.

Keywords: Nutrition ecology, nutrition-ecological modelling technique, NutriMod, complexity, prevention, overweight/obesity, cause-effect model

Introduction

The prevalence of overweight/obesity has developed into a worldwide 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 prevention measures do not adequately consider the complexity of the problem [5].

Against this background, the present study depicts and investigates the complex phenomenon of overweight/obesity with the help of NutriMod, a nutrition-ecological modeling technique. A qualitative cause-effect model is used to visualize the interactions between the causing and resulting factors of overweight/obesity described in literature. Examples are presented to demonstrate additional insights into overweight/obesity and for the development of prevention measures which may be identified by the presentation and investigation of the complex phenomenon.

Developing the model: the modeling technique NutriMod

A qualitative cause-effect model was developed on the basis of scientific literature, with the help of the nutrition-ecological modeling technique (Nutrition-ecological Modelling) (Figure 1) [6, 7]. In accordance with the nutrition-ecological approach [8, 9] the four dimensions of nutrition – health, society, environment and economy – were considered. Between March 2006 and February 2009, scientific literature was collected from 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 di-
Fig. 1: Qualitative Model of Causes and Effects of Overweight/Obesity [10]

- Food supply
  - Advertising
  - Food availability
  - Serving size
  - External stimuli
  - Price
  - Food composition
  - Labelling

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

- Agents of socialisation
  - Media
  - Peer groups
  - School/kindergarten
  - Family

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

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

- Lifestyle factors
  - Nutrition behaviour
  - Physical activity
  - Media consumption
  - Sleeping behaviour
  - Smoking

- Social change
  - Affluent society
  - Fast-paced lifestyle
  - Ideal of beauty
  - Urbanization
  - Women's employment
  - Household structures
  - Religion

- Biological factors
  - Hormones/cytokines/other factors
  - Genetics
  - Age
  - Sex

- Prenatal and infantile factors
  - Infant nutrition
  - Birth weight

- Environmental pollution

- Technological progress/globalization

- Migration

- Nutrition competences

- Infrastructure/neighbourhood

- Summarized factors

- Causal relationship

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

Causing factors of overweight/obesity

Overweight/obesity is influenced by numerous causing factors. A distinction must be made between direct and indirect factors. The cause-effect model shows only two factors which directly influence overweight/obesity: energy balance, which results from the ratio of energy intake to energy expenditure, and biological factors, which summarize genetic predisposition (genetics in the model) and hormones/cytokines/other factors. All other factors described in literature affect the development of overweight/obesity indirectly and almost exclusively act via energy balance. For example, social change is an indirect causing factor, which can contribute to a positive energy balance [11] and therefore to the development of overweight/obesity via 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 “cause-effect chains”. The model can be used to identify and retrace these cause-effect chains.

Resulting factors of overweight/obesity

Apart from numerous causing factors, overweight/obesity has many resulting factors. The model shows that there are both direct and, via cause-effect chains, indirect effects. For example, overweight/obesity directly causes costs due to necessary adaptations in means of transportation [12] or operating tables [13] arising from changes in body size (in the model: adaption 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

Cause-effect chains can close to form cause-effect circles, called feedback loops. These become apparent when the causal relationships between factors are depicted in a cause-effect model. For example, overweight/obesity can directly result in an increased risk of suffering from depression, negative body image and low self-esteem in affected individuals [14]. These mental factors can then again lead to changes in nutrition behaviour and physical activity, causing a consistently positive energy balance [15], which may enhance overweight/obesity [16], thus closing the cause-effect circle. Like most feedback loops in this model, this is a positive feedback and thereby a vicious circle.

As a result of feedback loops, causes can become effects and vice versa. Thus, mental factors initially are a direct resulting factor of overweight/obesity, but, due to the described feedback loop, become an indirect influence on its development or promotion. Consequently, in such a complex phenomenon it is not always possible to distinguish cause from effect. Visualization of the relationships can support revealing factors which can be both cause and effect at the same time.

Multicausality

Aside from cause-effect chains and feedback loops, the model allows rec-
ognizing multicausalities, i.e. when a factor has several causes. For example, the model shows that mental factors are not only influenced by the above mentioned cause overweight/obesity, but also by numerous other factors, such as social change, lifestyle factors, agents of socialization, etc.

Multidimensionality

In accordance with the nutrition-ecological approach, causing and resulting factors of overweight/obesity are assigned to the four dimensions of nutrition (health, environment, economy and society). As a result of the visualization as a cause-effect model, it becomes evident that factors of different dimensions interact. This implies that cause-effect chains and feedback loops may proceed over more than a single dimension of nutrition, and therefore are dimension transcending. 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. As a consequence of overweight/obesity numerous comorbidities (dimension health) may develop, leading to increased costs (dimension economy).

Considering the complex phenomenon in prevention measures

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

However, the cause-effect model of the complex phenomenon of overweight/obesity shows that a multitude of factors influence nutrition behaviour and physical activity. These are themselves influenced by other factors. This means that the causes for the development of overweight/obesity are frequently proceeding to nutrition behaviour and physical activity and act via cause-effect chains. Moreover, the cause-effect model reveals feedback loops, through which effects may become causes and through which reinforcing effects may possibly lead to vicious circles.

For a prevention measure to be successful, it is therefore necessary to identify causes or possible starting points related to both direct and obvious causing factors, as well as indirect preceeding causing factors along cause-effect chains, as well as to recognize and consider feedback loops [see 18].

Insights about multicausal interactions between the factors are crucial since the influence of a prevention measure can counteract other influences within the complex phenomenon. Thus, both the factor used as a starting point for the prevention measure as well as independent of this, other factors along the according cause-effect chain may be affected by other factors. If these influences are neglected they may attenuate or prevent the success of the measure. For example, a measure to increase schoolchildren’s motivation to eat more fruit and vegetables (in the model: food preferences as a subfactor of nutrition behaviour) would not be successful if it neglected the existing opinions and trends in the peer group. Or, the motivation may

Glossary:

Nutrition ecology is a scientific discipline dealing with the interaction between a multitude of factors in the dimensions health, environment, society and economy, along the complete food supply chain. In order to develop integrative solution approaches for complex nutrition-associated problems, multidimensionality and complexity in the field of nutrition are investigated and considered [23].

NutriMod (Nutrition-ecological modelling) is a modelling technique used to develop a qualitative cause-effect model on the basis of scientific literature and expert knowledge. According to the nutrition-ecological approach [8] the method is characterized by including the four dimensions of nutrition (health, society, environment and economy) along the complete food supply chain, so that all relevant aspects of a complex theme are considered [6].

Interdisciplinarity means that scientists from at least two disciplines cooperate concerning common objectives and results [19]. The intention is to combine their disciplinary perception and knowledge to an integrated, not additive result. True interdisciplinary research defines and solves its problems independently of disciplines [20].

Transdisciplinarity combines interdisciplinarity with the participation of non-scientific actors [e.g. 19, 21]. Participation means that actors affected by the problem and having an own perspective concerning the problem to be solved (e.g. government, economics, civil society) are actively involved in shaping the research process. The aim of transdisciplinarity is to contribute to solve so-called “real world problems” [22].
be enhanced, but along the cause-effect chain no change in food selection (subfactor of nutrition behaviour) is induced, because fresh fruit and vegetables may not be available at work or in school (in the model: availability) or the price is too high.

For prevention of overweight/obesity it is therefore necessary to consider the multicausalties apparent through the model.

As the phenomenon is multidimensional the conception of prevention measures requires involving different scientific disciplines and fields of practice via interdisciplinary and transdisciplinary approaches. The model can support the identification of the relevant actors by visualizing different factors in single dimensions [7, 8].

Conclusion

If prevention measures are to be successful, it is important to take into account the complexity of the phenomenon of overweight/obesity. For this, it is necessary to enhance the understanding for the multidimensional interaction of causing and resulting factors and to recognize cause-effect chains, feedback loops and multicausality. Accordingly, the nutrition-ecological modelling technique NutriMod was used to visualize the direct and indirect causing and resulting factors of overweight/obesity with their complex and multidimensional interactions in a qualitative cause-effect model. This visualization can enhance the understanding of the problem and thus provide a basis for the conception and implementation of effective prevention measures. The model makes it apparent that in addition to two direct causing factors numerous indirect factors along cause-effect chains and feedback loops contribute to the development and promotion of overweight/obesity. Thus, the model can support to identify decisive causes, which may have been neglected or which root in vicious circles. These may then provide possible starting points for prevention measures. The model also reveals which factors might interfere the success of a measure, if their multicausal interactions are not recognized and considered. The model also portrays the multidimensionality of overweight/obesity, allowing to identify relevant disciplines and fields of practice for inter- or transdisciplinary approaches, which can be incorporated into the conception of prevention measures.

The present qualitative cause-effect model thus provides a good basis to allow for the complexity of the phenomenon of overweight/obesity and to develop appropriate prevention measures.

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