THE GENETICS OF EXERCISE BEHAVIOR AND PSYCHOLOGICAL WELL-BEING - JANINE STUBBE

Introduction

Why do some people like to run in their leisure time, while other people prefer to watch a video? Are these individual differences in exercise behavior determined by differences in their environment (for example spouse's exercise behavior, job, school or upbringing) or by differences in genetic predisposition? These are the main questions of this thesis. Furthermore, it is investigated whether there is an association between exercise behavior and psychological well-being and what the cause of this relation is. An important hypothesis is that there is a relationship, but that this association is not causal. For example, differences between people in exercise behavior and psychological well-being might partly be explained by a common underlying set of genes. Firstly, it is tested whether there are genetic influences on well-being, and secondly, it is evaluated whether these genetic influences on well-being overlap with the genetic influences on exercise behavior.

Family study on health and life style

This study is part of an ongoing study on health and lifestyle in twin families registered with the Netherlands Twin Registry (NTR). Since 1991 every two to three years twins and their families have received a survey sent by mail containing a number of personality inventories, and items about health, regular exercise, alcohol consumption and smoking behavior. In October 2002, questionnaires were sent to twins, their spouses, parents, and siblings. Comparing correlations of MZ and DZ twins provides information about the nature of the influences contributing to the twin resemblance. MZ twins are genetically identical, while DZ twins share on average half of their segregating genes. If MZ twins will resemble each other more than DZ twins on for example well-being scores, this is an indication that genetic factors play an important role in explaining individual differences in well-being.

Genetic of exercise behavior

Twin studies with smaller samples have already shown that genetic factors contribute to individual differences in exercise behavior. Chapter two of the thesis gives a review of these studies and two important findings stand out. Firstly, the influence of genes does not remain constant during a life-time. This means that individual differences in exercise behavior between children will have other causes than differences in adult exercise behavior. Secondly, all adult twin studies show that genetic factors explain differences in exercise behavior. These findings are confirmed by our own research in chapter four and five

Chapter four describes the results of a study on the causes of individual differences in exercise behavior in a sample of Dutch male and female twins between the ages of 13 and 20 years. Until the age of 16 genes are of no importance in explaining individual differences in exercise behavior, while common environmental factors (i.e. upbringing, social economic status and school) do play an important role.

From the age of 17–18 years, genes are of importance for the first time, and the role of common environment decreases. Round the age of 19 and 20 years there is a peak in the influence of genetic factors on exercise behavior. More than 80% of the differences between people in exercise behavior are explained by genes. After this genetic peak the influence of genes decreases.

What might explain the genetic peak at age 19 and 20 years? A first explanation is that the influence of unique environmental factors like work pressure and lack of time might increase, resulting in a decreasing influence of genes. Secondly, during adolescence different genes might be of importance than during adulthood. Genes that play a role in how good you are in exercise may mainly be of importance in adolescence. This effect might decrease during adulthood, where genes that influence the mental and long-term effects of exercise might be of importance. However, these are speculations and a longitudinal research design is required to test these hypotheses.

Chapter five gives an overview of the GenomEUtwin project (i.e. Genome-wide analyses of European twin and population cohorts to identify genes predisposing to common disease). This project entails one of the largest research consortia in genetic epidemiology in the world with a collection of over 0.8 million twins. Self-reported data on frequency, duration, and intensity of exercise behavior from Australia, Denmark, Finland, Norway, the Netherlands, Sweden, and United Kingdom were used to create an index of exercise participation in each country. Results obtained in 85,198 twins aged 19–40 years showed a median heritability of exercise participation of 62% across the seven countries. Shared environmental effects played a role only in exercise participation of the Norwegian males (37%), but were of no importance in the other countries.

Heritability plays on important role in explaining individual differences in exercise behavior in European countries. Which genes might explain these findings? Until now, five genes are associated with exercise behavior. The CYP19 (aromatase) gene, a calcium-sensing receptor gene, and a common variant in a gene for one of the key receptors in the dopaminergic system (DRD2) were associated with female exercise behavior. It is not clear whether these genes might influence exercise behavior in men. For both men and women, the Melanocortin-4 receptor gene showed significant associations with moderate-to-strenuous physical activity and with inactivity. Finally, the Angiotensin Converting Enzyme (ACE) influences exercise behavior. The number of genetic studies worldwide is still limited. Given the role of exercise behavior in health issues this is an undesirable situation.

The association between exercise behavior and psychological well-being

Beside the genetics of exercise behavior, this thesis examined the association between exercise behavior and psychological. Are exercisers more satisfied with their lives and happier than non-exercisers? Chapter seven gives an overview of the studies focusing on the association between exercise and negative well-being. These studies show that regularly exercisers are less depressed, anxious and neurotic than non-exercisers. A limitation of these studies is that they only focus on negative outcomes of well-being. To get more insight in the association between exercise behavior and positive well-being, we

asked twins and their family member's questions about happiness and satisfaction with life. Chapter six shows that individual differences in positive well-being can be partly explained by genes (38%). From chapter seven can be concluded that exercisers are happier and more satisfied with their lives than non-exercisers. This finding was consistent for all age groups. Our study is the first large scale study that confirms the idea that exercise is associated with positive well-being and not only with negative well-being. Finally, we investigated the cause of the association between exercise behavior and psychological well-being. Both characteristics are largely influenced by the same set of genes. This means that genes explaining individual differences in exercise behavior largely explain individual differences in positive well-being.

Future research

The prevailing theoretical perspective in preventive medicine now holds that social and environmental factors largely account for voluntary lifestyle choices. Here, in contrast, it is shown that in adulthood some of the choices for a healthy lifestyle reflect differences in genetic make-up, although potentially in interaction with shared environment. This requires a change in our perspective, such that we change from "population-based" intervention strategies to "personalized" intervention strategies. Currently, this concept of "personalized medicine" is increasingly being applied to curative medicine and pharmacotherapeutic intervention. We suggest extending this concept to preventive medicine.