Prevention of type 2 diabetes: modeling the cost-effectiveness of diabetes prevention

Anne Neumann
Abstract

**Background:** Diabetes is a common and costly disease that is expected to continue even to grow in prevalence and health expenditures over the coming decades. Type 2 diabetes is the most common diabetes type and is characterized by insulin resistance and relative insulin deficiency. Type 2 diabetes develops over a long period and is often undetected over years. During this time, people almost always first develop any of the pre-diabetic states, i.e. impaired fasting glucose (IFG), impaired glucose tolerance (IGT) or a combination of both (IFG&IGT). This thesis focuses on type 2 diabetes only. In the following, the term diabetes is used to refer to type 2 diabetes only. Diabetes is associated with a sedentary lifestyle and obesity. While those are not the only factors contributing to the development and maintenance of diabetes, several studies have shown that prevention of diabetes among individuals at high risk through lifestyle change is possible, effective and cost-effective, especially targeting diet and exercise to reduce weight. No previous study had, however, estimated the cost-effectiveness of diabetes prevention strategies from a population-based perspective including healthy individuals and also considered IFG and IGT as two distinct pre-diabetic states.

**Objective:** The overall objective of this thesis was to establish, describe and evaluate a model that can assess the cost-effectiveness of lifestyle intervention programs to prevent diabetes.

**Methods:** First, a Markov Model was established using data from the literature. The cost of a German diabetes prevention program was estimated. Second, risk equations for change to worsened glucose states were estimated using factor analysis and logistic regression based on consecutive data from the Västerbotten Intervention Program (VIP). The risk equations described transition probabilities in the final model and were based on several risk factors such as age, sex, physical activity and smoking status. Third, information on the Short-Form 36 questionnaire from the VIP population was transformed into Short-Form 6D. Health utility weights (HUW) by glucose group and four risk factors were estimated using beta regression. Fourth, an updated Markov model was established using an updated model structure compared to the one in Paper I, program costs of Paper I, risk equations of Paper II, health utility weights of Paper III and updated cost and mortality estimates.

**Results:** The first model in Paper I showed that lifestyle intervention programs have the potential to be cost-effective with a high degree of uncertainty. The risk equations in Paper II indicated that the impact of each risk factor depended on the starting and ending pre-diabetes state, where high levels of triglyceride, hypertension, and high body mass index were the strongest risk factors to transit to a worsened glucose state. The overall mean HUW in Paper III was 0.764 with healthy individuals having the highest HUW, those with diabetes the lowest and those in pre-diabetic states ranging in between. The intervention described in Paper IV was cost-effective for all sex and age scenarios ranging from 3,833 EUR/QALY gained (women, 30 years) to 9,215 EUR/QALY gained (men, 70 years). The probability that the intervention is cost-effective was high (85.0-91.1%).

**Conclusion:** We established a model that can estimate the cost-effectiveness of different scenarios of initiatives to prevent diabetes. The prevention or the delay of the onset of diabetes is feasible and cost-effective. A small investment in a healthy lifestyle with the change in physical activity and diet together with weight loss can have a decent, cost-effective result. The full range of possibilities this model offers has not been evaluated so far. We have, however, shown that implementing a lifestyle intervention program like the Västerbotten Intervention Programme would be cost-effective.

**Key words:** type 2 diabetes mellitus, prevention, health economics, Markov modeling, risk equations, health-related quality of life, lifestyle modification, pre-diabetic states, cost-effectiveness, Västerbotten Intervention Programme