

# Diabetes complications, risk factors, and glycaemic indices in persons with type 1 diabetes

Akademisk avhandling

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## Avhandlingen baseras på följande delarbeten

- I. Hallström, S., Pivodic, A., Rosengren, A., Ólafsdóttir, A. F., Svensson, A. M., Lind, M. (2019). Risk Factors for Atrial Fibrillation in People With Type 1 Diabetes: An Observational Cohort Study of 36,258 Patients From the Swedish National Diabetes Registry. *Diabetes care*, 42(8), 1530–1538. <https://doi.org/10.2337/dc18-2457>
- II. Hallström, S., Svensson, A. M., Pivodic, A., Ólafsdóttir, A. F., Löndahl, M., Wedel, H., Lind, M. (2021). Risk factors and incidence over time for lower extremity amputations in people with type 1 diabetes: an observational cohort study of 46,088 patients from the Swedish National Diabetes Registry. *Diabetologia*, 64(12), 2751–2761. <https://doi.org/10.1007/s00125-021-05550-z>
- III. Hallström, S., Wijkman, M. O., Ludvigsson, J., Ekman, P., Pfeffer, M. A., Wedel, H., Rosengren, A., Lind, M. (2022). Risk factors, mortality trends and cardiovascular diseases in people with Type 1 diabetes and controls: A Swedish observational cohort study. *The Lancet Regional Health. Europe*, 21, 100469. <https://doi.org/10.1016/j.lanepe.2022.100469>
- IV. Hallström, S., Hirsch, I. B., Ekelund, M., Sofizadeh, S., Albrektsson, H., Dahlqvist, S., Svensson, A. M., Lind, M. (2021). Characteristics of Continuous Glucose Monitoring Metrics in Persons with Type 1 and Type 2 Diabetes Treated with Multiple Daily Insulin Injections. *Diabetes technology & therapeutics*, 23(6), 425–433. <https://doi.org/10.1089/dia.2020.0577>

# Diabetes complications, risk factors, and glycaemic indices in persons with type 1 diabetes

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## Abstract

**Background:** Persons with type 1 diabetes are at higher risk of cardiovascular disease and mortality. An important risk factor for diabetes complications is hyperglycaemia. Hyperglycaemia has traditionally been measured using HbA1c, but glycaemic targets are also provided for continuous glucose monitoring. The relation between HbA1c and glycaemic indices from continuous glucose monitoring is complex.

**Aims:** This thesis aims to evaluate modern diabetes treatment by estimating potential changes in prognosis over time in persons with type 1 diabetes. Another objective is to evaluate if new indices from continuous glucose monitoring can be correlated to HbA1c.

**Methods:** The populations of persons with type 1 diabetes in papers I, II, and III were retrieved from the Swedish National Diabetes Register and linked to other national registers to collect information on socioeconomic factors, comorbidity, mortality, and diabetes complications. In paper III, each person with type 1 diabetes was matched to 5 controls from the Swedish Total Population Register. In paper IV, data from continuous glucose monitoring from two cohorts of persons with type 1 or type 2 diabetes was analysed. To estimate the contributing risk of each risk factor, statistical Cox regression models have been created and adjusted for other risk factors. Mortality and incidence over time have been standardised by age and sex.

**Results:** The most important risk factors for atrial fibrillation in persons with type 1 diabetes were age and renal complications. Incidence rates for amputations in persons with type 1 diabetes decreased over time, and the most important risk factors for amputation were renal complications and hyperglycaemia. The cardiovascular prognosis for persons with type 1 diabetes and controls improved over time. For persons with type 1 diabetes without cardiorenal complications, mortality was similar to controls from the general population. At similar levels of HbA1c, time in range was higher in persons with type 2 diabetes than in persons with type 1 diabetes.

**Conclusions:** Prognosis has improved over time in persons with type 1 diabetes, and risk factor burden, renal complications, and hyperglycaemia must be considered in evaluating the current risk of complications and treatment decisions. The correlation between HbA1c and continuous glucose monitoring indices is strong but varies depending on individual factors and type of diabetes. This should be considered in clinical settings of glycaemic targets and guidelines.

**Keywords:** Type 1 diabetes, type 2 diabetes, diabetes complication, HbA1c, CGM