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THE ECONOMIC IMPACTS OF AUTOIMMUNE TYPE 1 DIABETES: EVIDENCE ON EDUCATION AND LABOR MARKET OUTCOMES IN THE UNITED STATES

ADOPTION AND PUBLIC REIMBURSEMENT OF SCREENING FOR AUTOIMMUNE TYPE 1 DIABETES (aT1D) IN CANADA

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Abstract

This thesis investigates the causal impact of autoimmune Type 1 Diabetes (aT1D) on education and labor market outcomes in the U.S, using NHIS data from 2016 to 2020. Linear regression models reveal that individuals with aT1D, on average, are significantly less likely to enter college and be employed, specifically in physically demanding occupations, while likely displaying lower worker productivity, compared to peers. This results in heterogenous life-cycle effects until the peak of individual's careers, affecting subsequent generations. The findings are robust to alternate logistic methods. The study demonstrates the socioeconomic burden of aT1D and importance of early detection for policymakers.

Keywords: Health Economics, Public Policy, Human Capital, Education, Labor Market, Worker Productivity, Occupational Selection

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1 Introduction

Diabetes represents a growing health issue, affecting around 830 million people globally in 2022 (WHO 2023). The condition has two main varieties: type 2 diabetes, which accounts for about 90% of cases and primarily affects adults (IDF 2025a), and autoimmune type 1 diabetes (aT1D), constituting 5 to 10% of global incidences (CDC 2024a). While aT1D can occur at any age, it mostly presents in children and, over time, can cause serious damage to blood vessels, kidneys, eyes, nerves, and the heart (WHO 2023). Hence, managing aT1D requires constant healthcare access and insulin for survival. In 2022, an estimated 8.75 million people worldwide had aT1D, mainly in high-income countries (IDF 2025b; WHO 2023). Its global prevalence is rising rapidly, with forecasts suggesting up to 17.4 million cases, almost double the current number, by 2040 (Gregory et al. 2022). In Canada, around 300,000 individuals are diagnosed with aT1D, with cases increasing by 4.4% annually – significantly outpacing its population growth of 1.0% (Breakthrough T1D 2025a). In the U.S., 1.8 million people were diagnosed in 2021 (CDC 2024b), with prevalence rising at 2% per year versus the country's population growth of just 0.5% (Wagenknecht et al. 2023; World Bank 2024). This rise imposes substantial health and economic burdens, affecting patients' personal and professional development.

In this context, the Global Alliance in Management Education (CEMS) team at Ivey Business School, together with a leading healthcare company, devised a Business Project in Spring 2025. The project delivered an advocacy strategy for the adoption and public reimbursement of aT1D autoantibody screening in Canada, promoting early detection and mitigating long-term health impacts. However, while early diagnosis is critical for health outcomes, aT1D's continuous treatment demands may also hinder individuals' educational and labor market trajectories. Therefore, this paper investigates the causal effect of aT1D on educational attainment, employment, occupation type, and worker productivity, using data from the U.S. National Health Interview Survey from 2016 to 2020.

Past literature has investigated the impact of aT1D on education and different labor market outcomes. Evidence on the effects of aT1D on educational attainment is mixed but generally suggests a negative relationship. A systematic literature review conducted by Oakley et al. (2020) reveals a weak negative link between aT1D and overall grade attainment in Swedish schools. Several studies report that children with aT1D face greater school absenteeism, learning difficulties, and lower academic performance, especially when glycemic control is poor (Fleming et al. 2019; French et al. 2022). Research by Bowden et al. (2024) finds lower educational attainment and university entry among aT1D diagnosed children. In contrast, some studies determine no significant differences in academic performance due to aT1D (Skipper et al. 2019; Mitchell et al. 2022), a result that might occur due to effective disease management or healthcare access of diagnosed children. Thus, while aT1D itself may not always reduce educational attainment, poor management of the condition often does.

In terms of labor market outcomes, research on the effects of aT1D remains limited, and most studies do not distinguish between diabetes types. Hakkarainen et al. (2017) found that working-age individuals with aT1D in Finland had slightly lower employment rates at 82% than the general population at 84%. A systematic review by Breton et al. (2013) concluded that any type of diabetes is significantly associated with reduced work ability, including higher absenteeism and productivity losses. Other studies across Europe and North America show that individuals with diabetes are less likely to be employed and more likely to exit the workforce early compared to the general population (Alavinia and Burdorf 2008; Herquelot et al. 2011; Kurkela et al. 2021). The condition is consistently linked to increased absenteeism, productivity loss, work limitations, and early retirement (Tunceli et al. 2005; Latif 2009). In fact, research from 1992 to 2022 estimates that diabetes generated over $58 billion in income losses in the U.S. alone due to disability, premature mortality, and reduced labor force participation, with aT1D contributing disproportionately given earlier onset and longer disease duration (Ng,

Jacobs, and Johnson 2001; Vijan, Hayward, and Langa 2004). Based on the evidence, having aT1D appears to significantly adversely affect labor market outcomes across dimensions.

This research contributes to the growing literature on the effect of aT1D on both education and the labor market. It provides a comprehensive analysis of educational attainment, employment and occupation type as well as worker productivity outcomes for individuals living with aT1D. By examining diverse impacts, the study offers an extensive view on the heterogenous life-cycle effects of aT1D diagnosis for patients. The implications are particularly valuable for policymakers in high-income countries which are currently experiencing an increased incidence of aT1D. Additional, the research complements existing findings by examining these effects in the largest world economy, the U.S. The analysis yields relevant policy implications and impactful calls to action for the continued livelihoods of nearly 2 million Americans, a number which is expected to increase further following current aT1D trends. Thus, this study aids in closing a relevant gap in the current literature.

The study finds that individuals diagnosed with aT1D face significant disadvantages in educational and labor market outcomes. Regression results indicate that aT1D is associated with lower rates of college entry and employment, as well as reduced work hours and earnings. The employment penalty, in combination with diminished worker productivity, is particularly pronounced in early to mid-adulthood. While no significant effects are found for a penalty out of high-skill occupations, individuals with aT1D are less likely to work in physically demanding jobs, signifying self-selection away from labor-intensive roles. Furthermore, having a family history of diabetes is consistently negatively associated with all education and labor market outcomes, suggesting the longevity of adverse aT1D-related impacts across generations.

This paper is structured as follows. First, a background on the development and health impacts of aT1D is provided and the context of this study within the completed Business Project is reviewed. Second, the data collection from the U.S. National Health Interview

Survey is described and the identification strategy to estimate the outcomes of interest is outlined. Third, the regression results of having aT1D on educational attainment, employment, and occupation type, as well as worker productivity are detailed. Fourth, the findings are discussed and main limitations presented. Final, the implications of the research are summarized to synthesize the findings.

2 Background

aT1D is a chronic condition and likely caused by an autoimmune reaction (IDF 2025b) of the body. The immune system mistakenly attacks vital beta cells in the pancreas which are necessary to create insulin, resulting in insufficient insulin production that can dangerously increase individual's blood glucose (or blood sugar) levels. The disease is formerly known as insulin-dependent, juvenile or childhood-onset diabetes due to its early age of onset, mostly developing in children, aged 4 to 6, and adolescents, aged 10 to 14 (Cleveland Clinic 2024). Nevertheless, aT1D can occur at any age. Currently, no environmental factors for its development are universally identified (Breakthrough T1D 2025b). However, some genetic predispositions for aT1D development have been found (CDC 2024a). First, individuals with a familial history of aT1D or potentially other autoimmune diseases are considered high-risk. This includes immediate relatives, such as parents, siblings, or children, of individuals with aT1D, in addition to those with other autoimmune conditions, such as celiac disease (Breakthrough T1D 2025b, Flores Monar et al. 2022). Second, individuals currently living with autoimmune diseases themselves are at elevated risk. These include patients with celiac disease, thyroid disorders, and autoimmune gastrointestinal conditions (Popoviciu et al. 2023). These risk groups can predict the manifestation of aT1D in a minority of instances.

Despite the genetic component, the occurrence of aT1D remains quasi-random. In fact, in over 90% of cases the disease develops in persons without identifiable genetic predispositions (Karges et al. 2020). Its incidence generally cannot be predicted as there are

no known reliable triggers. As it stands, the condition randomly appears in certain people. These persons are simply born with it, meaning that aT1D does not occur due to environmental factors during their lifetime but instead individuals will develop the disease at random.

Due to the early age of onset, aT1D significantly shapes the life experience of those affected. Even before diagnosis, individuals often experience the following symptoms: frequent urination, increased thirst, drowsiness, lethargy, blurred vision, weight loss, labored breathing and yeast infections (Breakthrough T1D 2025c). Once diagnosed, patients require access to healthcare to treat aT1D symptoms for their survival. In particular, individuals need to monitor their blood glucose levels at least 4 times a day, observe the carbohydrates they are consuming, and administer insulin accordingly (NHS 2025a). Affected persons effectively need to center their everyday life around disease management, including increasing physical activity and improving food choices. Combined with future concerns and stigma, this can lead to *diabetes distress*, which is emotional distress due to the aT1D-related burden of constant self-management – a common condition among affected young adults (Balfe et al. 2013, ADA 2021). Thus, aT1D treatment considerably influences the daily life of those living with the disease.

The numerous health-related hazards of aT1D are severe. On the one hand, individuals are at risk for *hypoglycemia*, the case of low blood sugar, causing dizziness, shaking, sweating, heart palpitations, unconsciousness and even seizures (NHS 2025b). On the other hand, there is a danger of *hyperglycemia*, which occurs in the case of elevated blood sugar. During severe hyperglycemic episodes, individuals may incur permanent damage to the nerves in their hands and feet (peripheral neuropathy), and eyes and sight (diabetic retinopathy). Some may even suffer potentially fatal conditions such as diabetic ketoacidosis (DKA), which often lead to hospitalization and long-term health implications (NHS 2025c). DKA, in fact, occurs mostly in individuals with aT1D, holding significant

risks for morbidity and mortality, as well as representing an economic burden (Virdi et al. 2023). The rates of DKA at aT1D diagnosis have risen critically in the last decades. In the U.S., the rate of DKA at manifestation of aT1D increased from 41 to 58% in Colorado children from 2010 to 2017 (Alonso et al. 2020). The same rate increased sharply from 36.4% in pre-Covid 2019 to 55% in 2020 in Canada (Sellers and Pacaud 2021). Due to its severity, DKA significantly diminishes an individual's health status and generates both direct and indirect costs (Rydén et al. 2016). In sum, aT1D presents serious long-term impacts for the life of afflicted persons.

The disruptive nature of aT1D adversely affects individual's educational and work lives. It can negatively impact individual's level of education in childhood as schooling might be disrupted through hospitalizations, physical limitations, mental strain, including rigid scheduling and planning needed for treatment management. Similarly, employment prospects may suffer, resulting in more unemployed individuals with aT1D compared with the rest of the population. Generally, worker productivity of the affected may be decreased due to high treatment demands, leading to consistently lower work hours and subsequent earnings in comparison to those without the condition. Over the individual's life cycle, these persistent adverse effects may result in significantly reduced educational and work attainments across different age groups.

aT1D may influence types of occupation that individuals are employed in. Specifically, patients may be penalized out of entry into high-skill, often high-paid professions due to systematic aT1D-related disadvantages in their educational attainment and employment, leading to skill mismatches. This penalty may be exacerbated by the requirements of daily aT1D management, limiting individual's ability to work long or flexible hours that are often necessary in these occupations. In addition, individuals with aT1D may self-select out of physically demanding occupations. As work in these fields often relies on manual labor for its execution, affected persons may have limited abilities to perform

based on intense treatment demands and long-term health implications. Increased quantities of non-aT1D diabetes-related complications, in fact, have been linked to physically demanding work (Nakazawa et al. 2022). This may lead to decreased overall employment of aT1D patients in such occupations, as they likely prefer jobs with lower physical demands and more workplace accommodations, with remote options, schedule regularity, and access to health insurance.

3 Business Project

3.1 Objective & Client Overview

The objective of the CEMS Business Project (BP) was to develop a comprehensive policy and advocacy strategy for the adoption and public reimbursement of screening for aT1D in Canada. It was conducted by a student team from Ivey Business School in collaboration with a leading healthcare organization. The organization is a biopharmaceutical company with global operations, which develops and delivers innovative therapeutic solutions in areas such as diabetes, oncology, immunology, and rare diseases. In accordance with its mission, the organization strongly emphases prevention, early intervention, and value-based healthcare initiatives. The BP client is the Canadian affiliate of this organization, actively engaging in partnerships with public health institutions and patient organizations.

Following the client's mission, early aT1D detection can significantly improve long-term health outcomes to generate significant healthcare cost savings, particularly among adults with recurrent DKA (Javor et al. 1997). The client aims to enable early detection of the condition nationwide through draw of a blood sample. This goal not only reinforces the client's commitment to patients but also positions itself as a key stakeholder in shaping sustainable, value-based healthcare delivery in Canada. (PHAC 2024)

The central challenge of the BP was addressing Canada's absence of a coordinated, publicly reimbursed screening program for aT1D. Healthcare delivery is decentralized on the federal level, with each province and territory responsible for its own policy and funding decisions. This fragmented structure leads to inconsistent coverage, lack of laboratory infrastructure for screening, and limited stakeholder alignment with regards to aT1D. Regions even rely on international facilities, such as U.S.-based laboratories, to process samples. This gap represents a missed opportunity for early intervention for the client, aligned with its broader strategic goals in preventative public healthcare and policy.

3.2 Key Findings & Recommendations

The BP provided the client with a clear and evidence-based roadmap to advocate for aT1D screening reimbursement. The project aligned public health priorities with fiscal sustainability and improved patient outcomes, combining strategic stakeholder engagement with robust financial modeling. It encompassed 4 key deliverables to supply the organization with a comprehensive strategy to tackle its goal in Canada.

First, the **healthcare landscape and reimbursement structures of each province and territory** were assessed. This included identifying key stakeholders, such as health ministry officials, laboratory networks, and policy advisors. These stakeholders were mapped to reveal influence pathways and decision-making processes across jurisdictions. The team recommended that the client employs a provincial and territorial advocacy strategy. Specifically, the implementation high-impact screening pilots in the key provinces of Ontario, Quebec, Alberta, and British Columbia, which comprise over 85% of the population, is advised to help gain federal coverage over time.

Second, **advocacy recommendations for the 2027 update of the *Framework for Diabetes in Canada*** of the Canadian government were provided. The team reviewed international case studies to compile successful aT1D screening models, including population-wide or high-risk testing structures in Europe (Karl et al. 2022; Cherubini et al.

2024), to devise evidence-based suggestions. The team recommended to inform advocacy efforts based on contemporary research to influence national screening guidelines and investments in laboratory capacity. Moreover, the client was advised to raise aT1D awareness through collaborations with organizations such as *Diabetes Canada*, and launch educational initiatives targeting clinicians, policymakers, and the public. This recommendation was closely tied to the insights gained for the following deliverable.

Third, a **methodology for a cost-benefit analysis (CBA) of DKA at diagnosis of aT1D** was outlined. This methodology detailed a framework to quantify the financial impact of early aT1D detection in terms of preventing DKA and incorporated data obtained from provincial health systems, academic literature, and public sources. Key cost inputs included hospitalization and ICU costs for DKA, screening expenses, and projected savings from avoided complications. These components were identified through academic research on DKA incidences and related costs. The team recommended to perform this CBA to actively advise ongoing advocacy efforts, especially the 2027 revision of the government's *Framework for Diabetes in Canada*.

Final, a **comprehensive 2-year timeline for phased strategy implementation** was given. This timeline was based on the insights gained through the first 3 deliverables and their synergies. Specifically, the 2027 revision of the *Framework for Diabetes in Canada* presents a time-sensitive opportunity to influence national policy. These efforts should be supported with evidence on the economic case for aT1D screening using pilot programs aimed at high-risk populations in key provinces. In addition, it was recommended to adjust the strategy based on key performance indicators (e.g. reduction in DKA rates at aT1D diagnosis) which should be continuously monitored and evaluated. The analysis was supplemented with strategic planning tools such as SWOT analysis, the CAGE framework, and a decision tree model to visualize the implementation process. Overall, the BP demonstrates the relevance of early aT1D detection and associated economic impacts.

4 Data

This paper utilizes annual cross-sectional data of the National Health Interview Survey (NHIS) of U.S. individuals from the years 2016, 2017 and 2020. The NHIS is performed since 1957 by the U.S. government, namely its *Centers for Disease Control and Prevention*'s (CDC) *National Center for Health Statistics*. In the years of analysis, the survey provides diabetes-related variables in its Sample Adult Diabetes supplements, sponsored by the *National Institute of Diabetes and Digestive and Kidney Diseases* and *National Center for Chronic Disease Prevention and Health Promotion*. The survey is conducted annually through confidential, in-person interviews with around 27,000 adults aged 18 years or older during the respective years (CDC 2024c). It collects information on individuals and their children's socio-economic standing, health status, healthcare access, and related behaviors. The NHIS data offers several advantages, such as the large size of survey responses and inclusion of detailed parameters, providing accurate representation of the civilian, non-institutionalized population in the U.S. (IPUMS NHIS 2025a). The harmonized dataset was extracted from IPUMS Health Surveys, compiled by Blewett et al. (2024). In the years 2016, 2017 and 2020, the dataset contains a total of 212,659 observations, covering a period of 3 years. In the final sample, this number is reduced to 134,316 observations by restricting the dataset to working age adults, from 18 to 64 years. Of these, 570 individuals are diagnosed with having aT1D. Detailed descriptive statistics of the sample can be found in Appendix A.

5 Methodology

To investigate the effects of having aT1D on educational attainment, employment and occupation type, as well as worker productivity, the Ordinary Least Squares (OLS) method is employed. This strategy is mainly adopted due to its ease of interpretability in the magnitude of results. To provide unbiased and consistent estimates, the treatment variable, in this case having aT1D, needs to be exogenous to the error term of the specification and cannot be

confounded with other factors. As outlined in section 2, developing aT1D is quasi-random, being triggered solely by an autoimmune reaction of the body with no environmental factors detected for its occurrence. The sole identified predisposition for its development is related to genetic features of an individual, including a family history of diabetes, which consistently predicts the treatment in less than 10% of cases (Karges et al. 2020). Thus, having immediate blood relatives with any type of diabetes is included as a control variable. This ensures exogeneity of the dependent variable across specifications. The following (linear probability) model is proposed:

$$Y_i = \beta_0 + \beta_1 \cdot aT1D_i + \beta_2 \cdot X'_i + \varepsilon_i$$

where the subscript *i* denotes an individual, Y_i refers to the vector of outcome variables, $aT1D_i$ is the treatment variable of having aT1D, X'_i signifies a vector of individual-specific control variables, and ε_i is the error term. The respective parameters are denoted by β_0, β_1, and β_2. The regression analysis is clustered by age to identify patterns across different age groups.

$aT1D_i$ is a dummy variable equal to 1 if an individuals has *aT1D*, and 0 otherwise. The indicator was based on corresponding survey responses on the type of diabetes of individuals who have ever been told they have the condition by a doctor or other health professional during the sample years. In the specifications analyzing the life-cycle effects of aT1D, the variable is further interacted with *10-year age group* dummies, starting from ages 18 to 24.

Y_i contains several dummies for educational attainment and labor market outcomes, as well as a continuous measurement of work hours. In terms of extensive margin effects, the dependent variables are *high school*, *college entry*, and *employment* dummies which indicate these outcomes at time of the survey, if equal to 1, and 0 otherwise. Completing *high school* is determined by the attainment of either a high school diploma, GED (General Equivalence Degree, which certifies individual's high school-level academic skills) or equivalent, while *college entry* is defined by the admission and attendance to college, including without a degree.

The individual has *employment* if in the last week they either had a job; or worked at a job or business, for pay or not for pay, including seasonal and contract work or any temporary absence due to vacation, family or maternity leave, illness or other reasons.

Further, Y_i encompasses general dummies for both high-skill and physically demanding occupations, as well as specific occupations within those categories, equaling 1 if individuals are either primarily or in the last 12 months employed in such occupations, and 0 otherwise. The general *high-skill occupations* dummy is comprised of jobs in *management*, *business and finance*, *computer and mathematical*, *legal*, *science* and similar fields. Regarding *physically demanding occupations*, the general dummy contains professions within *services*, *cleaning and maintenance*, *construction and extraction*, *farming* and *military* among others. For detailed information on the occupation categories, consult Appendix B.

To investigate worker productivity, Y_i denotes *work hours* and *above median earnings* for an individual. *Work hours* are the total hours that a working age adult in the sample worked in the past week, and, if applicable, in the past 2 weeks at all jobs or businesses, or at their main job or business. This variable is the only continuous outcome in the analysis. The measurement was collected only for individuals who in the last week either worked at a paid job, unpaid job or business; held a seasonal or contract position; or those who were not working due to vacation, family or maternity leave, or inability to work for health reasons. *Above median earnings* is a dummy variable, indicating if individual's earnings were above median earnings in the previous calendar year in the sample in the years 2016 and 2017. The outcome was identified using the available categories of the NHIS earnings variable. According to the data, most individuals' total earnings were between $25,000 to $34,999 in the previous calendar year, thus those with earnings from $35,000 are considered to receive above median earnings.

X'_i includes controls on individual's *sex*, *race*, and *family history of diabetes* in addition to *age*, *family size*, *education*, *region*, and *year* fixed effects, depending on the specification.

Family history of diabetes is an indicator reporting whether a sample adult has a parent or sibling who has ever been told by a doctor or other health professional that they have sugar diabetes or diabetes. The variable is restricted to blood relatives to capture a potential genetic component of individual's aT1D diagnosis. Due to the unavailability of key predictors in all years, such as urban or rural fixed effects and earnings, the analysis is mainly performed for the year 2020. The data from 2016 and 2017, however, is utilized to estimate the effect of aT1D on *above median earnings* only, as this outcome is not available beyond 2018. A detailed description of each control variable and applicable specifications is presented in Appendix C.

To test robustness, several additional logistic regressions of the main specifications are performed. These checks include only binary outcomes, namely *college entry*, *employment*, and *above median earnings*. The equations are estimated using the alternative method to confirm the identified associations with results reported in Appendix D.

6 Results

6.1 Educational Attainment & Employment

The regression results indicate that having aT1D adversely affects educational attainment and employment outcomes for diagnosed individuals. Table 1 reports the effects of having aT1D in the final sample on finishing high school, entering college, and being employed. Having aT1D is negatively associated with all outcomes, however, only the coefficients for college entry and employment are significant. According to the model, individuals with aT1D are 6.06 percentage points less likely to enter college (significant at the 5% level), and 10.19 percentage points less likely to participate in the labor force (significant at the 1% level) compared to peers, ceteris paribus. This result highlights the significance of aT1D diagnosis during individual's lifetime: the condition not only severely impacts their health but also potentially leads to a systematic disadvantage in their education and employment opportunities. Moreover, having an immediate blood relative who is diagnosed with (sugar) diabetes is

negatively associated with all outcomes. Having a family history of diabetes decreases the probability of finishing high school, entering college, and being employed by about .94 (significant at the 5% level), 3.75, and 2.82 percentage points (both significant at the 1% level), respectively, holding all other factors constant. These results indicate that unobserved shared genetic or socioeconomic factors of those with family members with diabetes may likely correlate with both educational success and employment. Due the consistency of this outcome across specifications, this variable may be a driving force of educational and employment disparities in the sample. Overall, having aT1D significantly negatively affects the educational attainment and employment prospects of affected persons, possibly due to the increased level of diabetes-related self-management, health considerations, and associated complications. Having aT1D may decrease the time available and physical ability for education and employment. Genetic and socioeconomic factors which have not been observed related to having diabetic family members may also be at play. The robustness tests in Appendix D confirm the results for college entry and employment.

Table 1. Educational attainment and employment effects of having aT1D.

	(1)	(2)	(3)
	High school	College entry	Employment
Having aT1D	-.0428	-.0606**	-.1019***
	(.0257)	(.0283)	(.0325)
Family history of diabetes	-.0094**	-.0375***	-.0282***
	(.0043)	(.0077)	(.0074)
R^2	0.0799	0.0928	0.0657
Number of observations	20,305	20,305	20,305

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Constant and control results, including sex, age, race, family size, and region, are omitted in the table. *** p<0.01, ** p<0.05, * p<0.1.

6.2 Types of Occupation

6.2.1 Penalty on High-Skill Occupations

The effects of having aT1D on the employment in high-skill occupations are shown in Table 2. The results indicate that there is no penalty for aT1D diagnosis for individuals in terms of high-skill jobs, both for the general dummy in column 1 and specific outcomes in columns 2 to 6. The coefficients exhibit no significant associations with aT1D diagnosis. Conversely, a

stated family history of diabetes is significantly negatively related to the general high-skill occupations dummy, including the separate management, business and finance and legal occupation variables. This result is not straightforward; it may occur due to unobserved shared genetic or socioeconomic factors that motivate individuals to pursue work in less high-skill occupations or potentially due to the indirect effects of diabetes on parent's educational attainment and employment prospects.

Table 2. Occupational penalty effects of having aT1D.

	(1) High-Skill Occupations	(2) Management	(3) Business & Finance	(4) Computer & Mathematical	(5) Legal	(6) Science
Having aT1D	-.0258	.0045	-.0181	.0050	.0042	.0100
	(.0315)	(.0213)	(.0130)	(.0138)	(.0082)	(.0110)
Family history of diabetes	-.0324***	-.0137***	-.0089**	-.0003	-.0044***	-.0023
	(-.0060)	(.0046)	(.0033)	(.0030)	(.0012)	(.0015)
R^2	0.0710	0.0187	0.0142	0.0399	0.0080	0.0053
Number of observations	20,030	20,030	20,030	20,030	20,030	20,030

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Constant and control results, including sex, age, race, family size, and region, are omitted in the table. *** p<0.01, ** p<0.05, * p<0.1.

6.2.2 Self-selection out of Physically Demanding Occupations

The results for the effect of having aT1D on the employment in physically demanding occupations are presented in Table 3. As expected, there appears to be significant reallocation of those with aT1D away from physically taxing work. Specifically, individuals with aT1D are 6.29 percentage points less likely to be employed in generally physically demanding occupations (significant at the 10% level); 1.86 percentage points less likely to be in cleaning and maintenance (significant at the 10% level); 2.25 percentage points less likely to be in construction and extraction (significant at the 5% level); .54 percentage points less likely to be in farming (significant at the 1% level); and .09 percentage points less likely to be in the military (significant at the 1% level), compared to those without, ceteris paribus. These results are in line with the findings of Nakazawa et al. (2022), who linked these occupations to amplified risks of diabetes-related complications for individuals with type 2 diabetes and other non-aT1D diabetes. Thus, those with the condition might be either consciously or unconsciously aware of

the inherent physical risks of these professions, self-selecting out these fields due to the perceived incompatibility with their aT1D-related day-to-day concerns. In contrast to high-skill occupation results, having a family history of diabetes is not significantly linked to the physically demanding occupation outcomes.

Table 3. Occupational selection effects of having aT1D.

	(1) Physically Demanding Occupations	(2) Services	(3) Cleaning & Maintenance	(4) Construction & Extraction	(5) Farming	(6) Military
Having aT1D	-.0629*	.0046	-.0186*	-.0225**	-.0054***	-.0009***
	(.0314)	(.0216)	(.0093)	(.0092)	(.0009)	(.0003)
Family history of diabetes	-.0013	.0024	-.0001	-.0034	.0002	-.0000
	(.0056)	(.0037)	(.0017)	(.0031)	(.0011)	(.0004)
R^2	0.0987	0.0194	0.0164	0.0480	0.0125	0.0019
Number of observations	20,030	20,030	20,030	20,030	20,030	20,030

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Constant and control results, including sex, age, race, family size, and region, are omitted in the table. *** p<0.01, ** p<0.05, * p<0.1.

6.3 Worker Productivity

Having aT1D significantly negatively affects productivity in terms of weekly work hours and earnings of workers. Table 4 shows the regression results of having aT1D on worker productivity outcomes. According to the model, aT1D diagnosis leads to 4.05 less work hours per week (significant at the 5% level), amounting to about half a workday less available during a work week for affected persons; and a 9.58 percentage points lower likelihood of having above median earnings (significant at the 1% level), compared to those without the condition, on average. The magnitude of the effects demonstrates the severe implications of aT1D on worker's productivity, diminishing obtainable work hours and subsequent earnings due to the routine demands of aT1D treatment and health limitations. Evidently, having aT1D affects both the extensive and intensive margin of patients, which need to be accounted for. The results for a lower likelihood of attaining above median earnings of aT1D workers are confirmed in the robustness tests in Appendix D.

Table 4. Worker productivity effects of having aT1D.

	(1) Work Hours in the last week or in the past 2 weeks at all/main jobs/businesses	(2) Above Median Earnings within the sample
Having aT1D	-4.05**	-.0958***
	(1.57)	(.0305)
Family history of diabetes	-1.15***	-.0184***
	(0.41)	(.0059)
R^2	0.0819	0.1584
Number of observations	20,305	29,110

Coefficients are rounded up to the second or fourth decimal point. Robust standard errors are reported in parentheses. Constant and control results, including sex, age, race, family size, year, and region, are omitted in the table. *** p<0.01, ** p<0.05, * p<0.1.

6.4 Life-Cycle Effects

Life-cycle effects of having aT1D on employment and worker productivity are displayed in Table 5. According to research, U.S. adults with full-time jobs reach the peak of their careers, in terms of median weekly earnings, between the ages of 45 and 54 (Tamborini, Kim & Sakamoto 2015). The coefficients in the table reveal that there is an employment penalty of aT1D persons specifically in the age groups 25 to 34 and 35 to 44. Over these ages, the employment gap with non-aT1D persons significantly widens. Being employed is 14.23 percentage points less likely for those with aT1D and aged 25 to 34 (significant at the 10% level), and 16.64 percentage points less likely for those with aT1D and aged 35 to 44 (significant at the 1% level), compared to peers, holding other factors constant. The employment penalty, thus, represents a significant risk for individuals as they work towards the peak of their careers. In terms of worker productivity, individuals with aT1D between the ages 24 and 35 work 6.99 hours less per week (significant at the 5% level), which amounts to almost a full day of work during a typical 8-hour per day work week, compared to those without aT1D, on average. This finding may be related to the physical toll of aT1D or other time-related limitations as a result of aT1D management, which particularly affects young adults at the beginning of their careers. Potentially, individuals have less experience in managing aT1D and their jobs simultaneously. Their habits in aT1D treatment are not yet adapted to the demands of working, leading to lower worker productivity. Additional, having aT1D and being aged 35 to 44 leads to 10.68

percentage points lower likelihood of obtaining above median earnings (significant at the 5% level), compared to peers, ceteris paribus. This result reveals that especially during the transition to the peak of individual's careers, aT1D takes its toll on earnings. It may be that in comparison with their non-aT1D counterparts, aT1D persons, who appear systematically advantaged in terms of education and employment opportunities, are less successful in acquiring high-paying jobs in this stage of life. Altogether, the results suggest that aT1D generates significant adverse life-cycle effects: the employment gap widens from young adulthood into the mid-point of individuals' careers, and worker productivity is particularly affected within the same age groups, initially decreasing work hours and ultimately resulting in lower earnings. The findings of tables 1 to 5, including control variable results, are available in Appendix E.

Table 5. Life-cycle effects of having aT1D.

	(1) Employment	(2) Work Hours in the last week or in the past 2 weeks at all/main jobs/businesses	(3) Above Median Earnings within sample
Having aT1D at different ages			
Having aT1D & aged 18-24	.0955	1.77	-.0389
	(.0875)	(4.02)	(.0710)
Having aT1D & aged 25-34	-.1423*	-6.99**	-.1107
	(.0791)	(2.75)	(.0761)
Having aT1D & aged 35-44	-.1646***	-3.74	-.1068**
	(.0576)	(3.15)	(.0454)
Having aT1D & aged 45-54	-.1208	-4.92	-.0690
	(.0740)	(3.44)	(.0512)
Having aT1D & aged 55-64	-.0754	-3.70	-.1220
	(.0478)	(2.70)	(.0787)
Family history of diabetes	-.0282***	-1.15***	-.0184***
	(.0074)	(0.41)	.0059
R^2	0.0659	0.0820	0.1584
Number of observations	20,305	20,305	29,110

Coefficients are rounded up to the second or fourth decimal point. Robust standard errors are reported in parentheses. Constant and control results, including sex, age, race, family size, year, and region, are omitted in the table. *** p<0.01, ** p<0.05, * p<0.1.

7 Discussion

As the results highlight, having aT1D is significantly negatively related to various socioeconomic outcomes in educational attainment and the labor market. Given the consistent significant negative effect of a family history of diabetes, the analysis demonstrates that the condition not only affects the individual, but also family members and subsequent generations.

The disease generates far-reaching detrimental impacts across cohorts, putting individuals with aT1D and their families at a systematic disadvantage compared to peers. Policymakers must account for these results. The employment penalty in early to mid-adulthood is particularly poignant, suggesting that increased effort for the education and support of aT1D employees is needed. Improved employer training, targeted employee education and early aT1D detection can help to offset the discovered impacts.

This study has several limitations. The effects are studied using a sample from the U.S., which represents a unique setting in terms of healthcare. It is the one of the few high-income countries with non-universal access to healthcare, while having the most expensive healthcare system in the world. Around 26 million U.S. citizens, representing almost 8% of the population, remain uninsured while nearly 25% of those with insurance are considered underinsured (Commonwealth Fund 2024a). In terms of costs, a quarter of Americans, aged 65 years and older, spend around $2,000 or more on healthcare per year, while similar expenses only apply to about 5% in France and the Netherlands (Commonwealth Fund 2024b). Overall, this leads higher inequality in healthcare access in the U.S. compared to Europe, significantly impacting health outcomes (Agency for Healthcare Research and Quality 2021). Hence, the results cannot easily be generalized to all other high-income countries. Moreover, previous studies identified a relevant link of the outcomes to individual's quality of diabetes management in terms of HbA1c (blood glucose) levels, years since initial diagnosis and occurrence of diabetes-related complications (Fleming et al. 2019; French et al. 2022; Tunceli et al. 2005; Ng, Jacobs and Johnson 2001). Though out of the scope of this paper, the inclusion of these variables may provide further insight into the mechanisms and drivers behind the aT1D-related effects.

8 Conclusion

This thesis investigates the causal effects of aT1D on educational attainment, employment, types of occupation, and worker productivity using data from the U.S. National

Health Interview Survey, including 2016, 2017 and 2020. The analysis demonstrates that individuals diagnosed with aT1D face substantial disadvantages across multiple socioeconomic dimensions. In particular, regression results show that aT1D significantly reduces the likelihood of college entry and employment participation, with diagnosed individuals being 6.06 percentage points less likely to enter college and 10.19 percentage points less likely to be employed compared to their peers, on average. Further, aT1D is linked to lower productivity, including 4.05 fewer weekly work hours and a 9.58 percentage point lower likelihood of earning above the median, on average, compared to non-aT1D counterparts. These effects persist across individual's life stages, with the largest employment gap observed during mid-career when aged 35 to 44 years. Additionally, while aT1D is not significantly associated with underrepresentation in high-skill occupations, it is significantly linked to self-selection out of physically demanding jobs, indicating a preference or necessity to avoid strenuous roles due to health limitations. Furthermore, a consistent and significant negative association between family history of diabetes and all socioeconomic outcomes suggests the persistence of adverse diabetes-related effects across generations.

These findings highlight the profound socioeconomic burden of rising aT1D prevalence beyond its clinical impacts in high-income countries. They underscore the importance of early screening and public health interventions, such as the proposed autoantibody screening strategy developed for the BP in Canada, to mitigate long-term disadvantages. For policymakers, the results advocate for targeted support systems, including educational accommodations, workplace protections, and expanded healthcare access to reduce the structural inequalities faced by individuals living with aT1D. Moreover, additional research on the outcomes, considering the differential healthcare access in other high-income countries such as Canada, is recommended. Utilizing further indicators of worker productivity in order to demonstrate aT1D-related effects may offer a more comprehensive view on the intensive margin effects.

References

Agency for Healthcare Research and Quality (US). 2021. *2021 National Healthcare Quality and Disparities Report*. Rockville, MD: Agency for Healthcare Research and Quality. https://www.ncbi.nlm.nih.gov/books/NBK578529/ (accessed May 27, 2025).

Alavinia, Seyed Mohammad, and Alex Burdorf. 2008. "Unemployment and Retirement and Ill-Health: A Cross-Sectional Analysis across European Countries." *International Archives of Occupational and Environmental Health* 82: 39–45. https://doi.org/10.1007/s00420-008-0304-6.

Alonso, G. Todd, Alex Coakley, Laura Pyle, Katherine Manseau, Sarah Thomas, and Arleta Rewers. 2020. "Diabetic Ketoacidosis at Diagnosis of Type 1 Diabetes in Colorado Children, 2010–2017." *Diabetes Care* 43 (1): 117–121. https://doi.org/10.2337/dc19-0428.

American Diabetes Association (ADA). 2021. *Mental Health Workbook: Chapter 3 – Psychological Barriers to Diabetes Medication Taking*. https://professional.diabetes.org/sites/default/files/media/ada_mental_health_workbook_chapter_3.pdf (accessed May 16, 2025).

Balfe, Myles, Frank Doyle, Diarmuid Smith, Seamus Sreenan, Ruairi Brugha, David Hevey, and Ronan Conroy. 2013. "What's Distressing about Having Type 1 Diabetes? A Qualitative Study of Young Adults' Perspectives." *BMC Endocrine Disorders* 13: 25. https://doi.org/10.1186/1472-6823-13-25.

Bowden, Nicholas, Rachael Dixon, Vivienne Anderson, Martin de Bock, Alisa Boucsein, Maria Kewene-Edwards, Sheree Gibb, Jesse Kokaua, Octavia Palmer, Ryan Paul, Barry Taylor, Hien Vu, and Benjamin J. Wheeler. 2024. "Associations Between Type 1 Diabetes and Educational Outcomes: An Aotearoa/New Zealand Nationwide Birth Cohort Study Using the Integrated Data Infrastructure." *Diabetologia* 67 (1): 62-73. https://doi.org/10.1007/s00125-023-06026-y.

Breakthrough T1D. 2024b. *Causes of Type 1 Diabetes*. https://www.breakthrought1d.org/t1d-basics/causes/ (accessed May 16, 2025).

Breakthrough T1D. 2025a. *Facts and Figures*. Breakthrough T1D Canada. https://breakthrought1d.ca/t1d-basics/facts-and-figures/ (accessed May 23, 2025).

Breakthrough T1D. 2025c. *Signs and Symptoms of Type 1 Diabetes*. Breakthrough T1D Canada. https://breakthrought1d.ca/t1d-basics/signs-symptoms/ (accessed May 16, 2025)

Breton, Marie-Claude, Line Guénette, Mohamed Amine Amiche, Jeanne-Françoise Kayibanda, Jean-Pierre Grégoire, and Jocelyne Moisan. 2013. "Burden of Diabetes on the Ability to Work: A Systematic Review." *Diabetes Research and Clinical Practice* 36 (3): 740–749. https://doi.org/10.2337/dc12-0354.

Centers for Disease Control and Prevention (CDC). 2024a. *About Type 1 Diabetes*. U.S. Department of Health and Human Services. https://www.cdc.gov/diabetes/about/about-type-1-diabetes.html (accessed May 23, 2025).

Centers for Disease Control and Prevention (CDC). 2024c. *About the National Health Interview Survey*. National Center for Health Statistics. https://www.cdc.gov/nchs/nhis/about/ (accessed May 19, 2025).

Centers for Disease Control and Prevention. 2024b. *Data and Research for Public Health Professionals*. Centers for Disease Control and Prevention. https://www.cdc.gov/diabetes/php/data-research/index.html (accessed May 23, 2025).

Cherubini, Valentino, E. Bonfanti, A. Bressan, A. Scaramuzza, R. Schiaffini, F. Ortolani, and F. Lombardo. 2024. "Follow-Up and Monitoring Programme in Children Identified in Early-Stage Type 1 Diabetes during Screening in the General Population of Italy." *Diabetes, Obesity & Metabolism* 26 (10): 4197–4202. https://doi.org/10.1111/dom.15399.

Cleveland Clinic. 2024. *Type 1 Diabetes*. https://my.clevelandclinic.org/health/diseases/21500-type-1-diabetes (accessed May 15, 2025).

Commonwealth Fund. 2024a. *Mirror, Mirror 2024: Benchmarking Health Care Performance Across Countries*. The Commonwealth Fund. https://www.commonwealthfund.org/publications/fund-reports/2024/sep/mirror-mirror-2024 (accessed June 2, 2025).

Commonwealth Fund. 2024b. *Health Care Affordability for Older Adults: How the U.S. Compares to Other High-Income Countries*. The Commonwealth Fund. https://www.commonwealthfund.org/publications/issue-briefs/2024/dec/health-care-affordability-older-adults-how-us-compares-other-countries (accessed June 2, 2025).

Diabetes Canada. 2022. *2022 Backgrounder: The Burden of Diabetes in Canada*. https://www.diabetes.ca/DiabetesCanadaWebsite/media/Advocacy-and-Policy/Backgrounder/2022_Backgrounder_Canada_English_1.pdf. (accessed May 14, 2025).

Fleming, Michael, Catherine A. Fitton, Markus F. C. Steiner, James S. McLay, David Clark,

Albert King, Robert S. Lindsay, Daniel F. Mackay, and Jill P. Pell. 2019. "Educational and Health Outcomes of Children Treated for Type 1 Diabetes: Scotland-Wide Record Linkage Study of 766,047 Children." *Diabetes Care* 42 (9): 1700–1707. https://doi.org/10.2337/dc18-2423.

Flores Monar, Gabriela V., Jhosselyn S. Chang, Valeria C. Moreira, and Estefania P. Salazar. 2022. "Association Between Type 1 Diabetes Mellitus and Celiac Disease: Autoimmune Disorders with a Shared Genetic Background." *Cureus* 14 (3): e22912. https://doi.org/10.7759/cureus.22912.

French, Robert, Dylan Kneale, Justin T. Warner, Holly Robinson, James Rafferty, Adrian Sayers, Peter Taylor, John W. Gregory, and Colin M. Dayan. 2022. "Educational Attainment and Childhood-Onset Type 1 Diabetes." *Diabetes Care* 45 (12): 2852–2861. https://doi.org/10.2337/dc21-0693.

Gregory, Gabriel A., Thomas I. G. Robinson, Sarah E. Linklater, Fei Wang, Stephen Colagiuri, Carine de Beaufort, Kim C. Donaghue, Dianna J. Magliano, Jayanthi Maniam, Trevor J. Orchard, Priyanka Rai, and Graham D. Ogle. 2022. "Global Incidence, Prevalence, and Mortality of Type 1 Diabetes in 2021 with Projection to 2040: A Modelling Study." *The Lancet Diabetes & Endocrinology*, 10 (10): 741–760. https://doi.org/10.1016/S2213-8587(22)00218-2.

Hakkarainen, Pirjo, Reijo Sund, Mika Gissler, Martti Arffman, Sari Koski, Vilma Hänninen, Leena Moilanen, and Kimmo Räsänen. 2017. "Working People with Type 1 Diabetes in the Finnish Population." *BMC Public Health* 17: 805(2017). https://doi.org/10.1186/s12889-017-4723-8.

Herquelot, Eléonore, Alice Guéguen, Sébastien Bonenfant, and Rosemary Dray-Spira. 2011. Impact of Diabetes on Work Cessation: Data from the GAZEL Cohort Study." *Diabetes Care* 34 (6): 1344–1349. https://doi.org/10.2337/dc10-2225.

International Diabetes Federation (IDF). 2025a. *Type 2 Diabetes*. https://idf.org/about-diabetes/types-of-diabetes/type-2/ (accessed May 15, 2025).

International Diabetes Federation (IDF). 2025b. *Type 1 Diabetes*. https://idf.org/about-diabetes/types-of-diabetes/type-1-diabetes/ (accessed May 15, 2025).

IPUMS NHIS. 2025a. *IPUMS Health Surveys: National Health Interview Survey (NHIS)*. IPUMS Health Surveys. University of Minnesota. https://nhis.ipums.org/nhis/ (accessed May 19, 2025).

IPUMS NHIS. 2025b. *2020 Occupational Classification (20OCC)*. IPUMS Health Surveys. University of Minnesota. https://nhis.ipums.org/nhis/20occ.shtml (accessed May 30,

2025).

IPUMS NHIS. 2025c. *2010 Occupational Classification (10OCC).* IPUMS Health Surveys. University of Minnesota. https://nhis.ipums.org/nhis/10occ.shtml. (accessed May 30, 2025).

IPUMS NHIS. *Variable Groups.* IPUMS Health Surveys. University of Minnesota. https://nhis.ipums.org/nhis-action/variables/group. (accessed May 30, 2025).

Javor, K. A., J. G. Kotsanos, R. C. McDonald, A. D. Baron, J. G. Kesterson, and W. M. Tierney. 1997. "Diabetic Ketoacidosis Charges Relative to Medical Charges of Adult Patients with Type I Diabetes." *Diabetes Care* 20 (3): 349–354. https://doi.org/10.2337/diacare.20.3.349.

Karges, Beate, Eckhard Sieber, Joachim Rosenbauer, and Thomas Danne. 2020. "A Comparison of Familial and Sporadic Type 1 Diabetes among Young Patients." *Diabetes Care* 44 (5): 1116–1124. https://doi.org/10.2337/dc20-1829.

Karl, Florian M., Stefanie Lanzinger, Andreas Beyerlein, Maren Pflüger, Nicole Bächle, and Anette-Gabriele Ziegler. 2022. "Costs of Public Health Screening of Children for Presymptomatic Type 1 Diabetes in Bavaria, Germany." *Diabetes Care* 45 (4): 837–844. https://doi.org/10.2337/dc21-1484.

Kurkela, Olli, Leena Forma, Pirjo Ilanne-Parikka, Jaakko Nevalainen, and Pekka Rissanen. 2021. "Association of Diabetes Type and Chronic Diabetes Complications with Early Exit from the Labour Force: Register-Based Study of People with Diabetes in Finland." *Diabetologia* 64: 795–804. https://doi.org/10.1007/s00125-020-05363-6.

Latif E. 2009. "The Impact of Diabetes on Employment in Canada". *Health Economics* 18 (5): 577–589. https://doi.org/10.1002/hec.1390.

Lynn A. Blewett, Julia A. Rivera Drew, Miriam L. King, Kari C.W. Williams, Daniel Backman, Annie Chen, and Stephanie Richards. IPUMS Health Surveys: National Health Interview Survey, Version 7.4 [dataset]. Minneapolis, MN: IPUMS, 2024. https://doi.org/10.18128/D070.V7.4.

Mitchell, Rebecca J., Anne McMaugh, Helen Woodhead, and Reidar P. Lystad, Yvonne Zurynski, Tim Badgery-Parker, Cate M. Cameron, and Tien-Ming Hng. 2022. "The Impact of Type 1 Diabetes Mellitus in Childhood on Academic Performance: A Matched Population-Based Cohort Study." *Pediatric Diabetes* 23 (3): 411–420. https://doi.org/10.1111/pedi.13317.

Nakazawa, Shoko, Kota Fukai, Yuko Furuya, Noriko Kojimahara, Keika Hoshi, Akihiro Toyota, and Masayuki Tatemichi. 2022. "Occupations Associated with Diabetes

Complications: A Nationwide-Multicenter Hospital-Based Case-Control Study." *Diabetes Research and Clinical Practice* 186: 109809. https://doi.org/10.1016/j.diabres.2022.109809.

Ng, Ying Chu, Philip Jacobs, and J. A. Johnson. 2001. "Productivity Losses Associated with Diabetes in the U.S." *Diabetes Care* 24 (2): 257–261. https://doi.org/10.2337/diacare.24.2.257.

NHS. 2025a. *Living with Type 1 Diabetes*. https://www.nhs.uk/conditions/type-1-diabetes/living-with/ (accessed May 16, 2025).

NHS. 2025b. *Low Blood Sugar (Hypoglycaemia)*. https://www.nhs.uk/conditions/low-blood-sugar-hypoglycaemia/ (accessed May 16, 2025).

NHS. 2025c. *High Blood Sugar (Hyperglycaemia)*. https://www.nhs.uk/conditions/high-blood-sugar-hyperglycaemia/ (accessed May 16, 2025).

Oakley, Natalie Jayne, Dylan Kneale, Mala Mann, Mariann Hilliar, Colin Dayan, John W. Gregory, and Robert French. 2020. "Type 1 Diabetes Mellitus and Educational Attainment in Childhood: A Systematic Review." *BMJ Open* 10 (1): e033215. https://doi.org/10.1136/bmjopen-2019-033215.

Popoviciu, Mihaela S., Anca Pantea Stoian, Marius-Ionut Ungureanu, and Bogdan Timar. 2023. "Type 1 Diabetes Mellitus and Autoimmune Diseases: A Critical Review of the Association and the Application of Personalized Medicine." *Journal of Personalized Medicine* 13 (3): 422. https://doi.org/10.3390/jpm13030422.

Public Health Agency of Canada (PHAC). 2022. *Framework for Diabetes in Canada*. Government of Canada. https://www.canada.ca/en/public-health/services/publications/diseases-conditions/framework-diabetes-canada.html (accessed May 14, 2025).

Robinson, Marie-Eve, Christel Pomares, Marie-Claude Pelland-Marcotte, and Julie A. Groleau. 2019. "Increasing Prevalence of Diabetic Ketoacidosis at Diabetes Diagnosis among Children in Quebec: A Population-Based Retrospective Cohort Study." *CMAJ Open* 7 (2): E300–E305. https://doi.org/10.9778/cmajo.20190047.

Rydén, Anna, Elisabeth Sörstadius, Klas Bergenheim, Alexandru Romanovschi, Fredrik Thorén, Edward A. Witt, and Catarina Sternhufvud. 2022. "The Humanistic Burden of Type 1 Diabetes Mellitus in Europe: Examining Health Outcomes and the Role of Complications." *Diabetes Therapy* 13 (3): 401–418. https://doi.org/10.1007/s13300-021-01189-0.

Sellers, Elizabeth A. C., and Danièle Pacaud. 2021. "Diabetic Ketoacidosis at Presentation of Type 1 Diabetes in Children in Canada during the COVID-19 Pandemic." *Paediatrics & Child Health* 26 (4): 208–209. https://doi.org/10.1093/pch/pxab017.

Skipper, Niels, Amanda Gaulke, Stine Møller Sildorf, Tine M. Eriksen, Nick Fabrin Nielsen, and Jannet Svensson. 2019. "Association of Type 1 Diabetes with Standardized Test Scores of Danish Schoolchildren." *JAMA* 321 (5): 484–492. https://doi.org/10.1001/jama.2018.21819.

Tamborini, Christopher R., ChangHwan Kim, and Arthur Sakamoto. 2015. "Education and Lifetime Earnings in the United States." *Demography* 52 (4): 1383–1407. https://doi.org/10.1007/s13524-015-0407-0.

Tunceli, Kaan, Cathy J. Bradley, David Nerenz, L. Keoki Williams, Manel Pladevall, and Jennifer Elston Lafata. 2005. "The Impact of Diabetes on Employment and Work Productivity." *Diabetes Care* 28 (11): 2662–2667. https://doi.org/10.2337/diacare.28.11.2662.

Vijan, Sandeep, Rodney A. Hayward, and Kenneth M. Langa. 2004. "The Impact of Diabetes on Workforce Participation: Results from a National Household Sample." *Health Services Research* 39 (6p1): 1653–1670. https://doi.org/10.1111/j.1475-6773.2004.00311.x.

Virdi, Naunihal, Yeesha Poon, Richard Abaniel, and Richard M. Bergenstal. 2023. "Prevalence, Cost, and Burden of Diabetic Ketoacidosis." *Diabetes Technology & Therapeutics* 25 (S3). https://doi.org/10.1089/dia.2023.0149.

Wagenknecht, Lynne E., Jean M. Lawrence, Scott Isom, Elizabeth T. Jensen, Dana Dabelea, Angela D. Liese, Lawrence M. Dolan, Amy S. Shah, Anna Bellatorre, Katherine Sauder, Santica Marcovina, Kristi Reynolds, Catherine Pihoker, Giuseppina Imperatore, Jasmin Divers, and SEARCH for Diabetes in Youth study. 2023. "Trends in incidence of youth-onset type 1 and type 2 diabetes in the USA, 2002–18: Results from the population-based SEARCH for Diabetes in Youth study." *The Lancet Diabetes & Endocrinology* 11(4): 242–250. https://doi.org/10.1016/S2213-8587(23)00025-6.

World Bank. 2024. "Population Growth (Annual %) – United States." *World Development Indicators*. https://data.worldbank.org/indicator/SP.POP.GROW?locations=US (accessed May 23, 2025).

World Health Organization (WHO). 2023. *Diabetes: Key Facts*. https://www.who.int/news-room/fact-sheets/detail/diabetes (accessed May 15, 2025).

Appendices

Appendix A. Descriptive Statistics of the Sample

Table 6. Descriptive statistics of the categorical variables of the sample.

	Non-aT1D population	aT1D population
Categorical variables		
Diabetes		
Having aT1D	99.54%	0.46%
Family history of diabetes	34.38%	58.94%
Educational attainment and employment		
High school or GED	24.90%	26.49%
College entry	31.41%	30.18%
Employment	74.32%	62.11%
High-skill occupations		
High-skill occupations	16.17%	24.91%
Management	4.81%	7.12%
Business & Finance	2.69%	3.56%
Computer & Mathematical	1.80%	2.31%
Legal	0.52%	0.71%
Science	0.53%	1.07%
Physically demanding occupations		
Physically demanding occupations	16.24%	32.03%
Services	3.44%	6.94%
Cleaning & Maintenance	1.85%	2.85%
Construction & Extraction	2.27%	4.09%
Farming	0.36%	0.71%
Military	0.11%	0.36%
Above median earnings	54.32%	45.42%
Female	51.95%	50.44%
Race		
White	78.52%	73.51%
Black	11.54%	18.25%
Asian	6.44%	3.16%
Hispanic	15.63%	12.98%
Other race	3.88%	3.68%
Family size		
1	16.60%	33.16%
2	29.67%	32.11%
3	19.97%	15.44%
4	18.46%	12.98%
5	9.42%	4.74%
6+	5.88%	1.58%
Regional interaction variables		
Northeast Central	5.22%	6.79%
Northeast Fringe	6.27%	6.17%
Northeast Small	4.68%	5.56%
Northeast Non-Metro	1.26%	1.85%
North Central/Midwest Central	5.42%	2.47%
North Central/Midwest Fringe	6.01%	8.02%
North Central/Midwest Small	6.97%	5.56%
North Central/Midwest Non-Metro	4.78%	4.94%
South Central	9.10%	11.73%
South Fringe	8.13%	4.94%
South Small	11.45%	16.67%
South Non-Metro	4.83%	9.88%
West Central	11.74%	3.09%
West Fringe	3.14%	3.09%
West Small	8.57%	5.56%
West Non-Metro	2.42%	3.70%
Number of observations	123,088	570

Table 7. Descriptive statistics of the continuous variables of the sample.

	Non-aT1D population	aT1D population
Continuous variables		
Age		
Age < 25 years	12.98%	8.42%
Age 25–44 years	41.68%	31.93%
Age 45–54 years	21.99%	24.39%
Age > 54 years	23.35%	35.26%
Mean	41.87	46.34
Standard deviation	13.51	12.98
Minimum	18	18
Maximum	64	64
Work hours per week		
Mean	30.47	25.21
Standard deviation	21.75	22.72
Minimum	99	0
Maximum	0	99
Number of observations	123,088	570

Numbers are rounded up to the second decimal point.

Appendix B. Categories for High-skill and Physically Demanding Occupations

Table X depicts the occupation categories for high-skill and physically demanding occupations. The general occupation dummy variables are created by adding the categories across the occupations. Specific occupations correspond to their respective descriptions.

Table 8. Categories of high-skill and physically demanding occupations.

Occupation groups	Description
High-skill occupations	
Management	Chief executives, general and operative managers, and legislators
	Advertising, marketing, promotions, public relations, and sales managers
	Administrative services, compensation/benefits, human resources, training, production, purchasing, and transportation/distribution, and other operations managers / Operations specialties managers
	All other management occupations
Business & Finance	Business operations specialists
	Financial specialists
Computer & Mathematical	Computer specialists
	Mathematical science occupations
Legal	Lawyers, judges, and related workers
	Legal support workers
Science	Life scientists
	Physical scientists
	Social scientists and related workers
	Life, physical, and social science technicians
Architecture & Engineering	Architects, surveyors, and cartographers
	Engineers
	Drafters, engineering, and mapping technicians
Education, Training & Library	Postsecondary teachers, primary, secondary, and special education school teachers
	Other teachers and instructors
	Librarians, curators, and archivists
	Other education, training, and library occupations
Arts, Design, and Media Occupations	Arts and design workers
	Media and communication workers
	Media communication equipment workers
Physically demanding occupations	
Services	First-line supervisors/managers, protective service workers
Protective Service	Firefighting and prevention workers
	Law enforcement workers
	Other protective service workers
Personal Care and Service	Supervisors, personal care and service workers
	Animal care and service workers
	Entertainment attendants and related workers
	Funeral service workers
	Personal appearance workers
	Transportation, tourism, and lodging attendants
	Other personal care and related workers
Community & Social Service	Counselors, social workers, and other community and social service specialists
	Religious workers
Food Preparation & Serving Related	Supervisors, food preparation, and serving workers
	Cooks and food preparation workers
	Food and beverage serving workers
	Other food preparation and serving related workers

Table 8 (continued). Categories of high-skill and physically demanding occupations.

Occupation groups	Description
Physically demanding occupations	
Cleaning and Maintenance	Supervisors, building and grounds cleaning and maintenance workers Building cleaning and pest control workers Grounds maintenance workers
Construction and Extraction	Supervisors, construction and extraction workers Construction trades workers Helpers, construction trades Other construction and related workers Extraction workers
Farming	Supervisors, farming, fishing, and forestry workers Agricultural workers Fishing and hunting workers Forest, conservation, and logging workers
Military	Military specific occupations
Installation, Maintenance & Repair	Supervisors of installation, maintenance, and repair workers Electrical and electronic equipment mechanics, installers, and repairers Vehicle and mobile equipment mechanics, installers, and repairers Other installation, maintenance, and repair occupations
Production	Supervisors, production workers Assemblers and fabricators Food processing workers Metal workers and plastic workers Printing workers Textile, apparel, and furnishing workers Woodworkers Plant and system operators Other production occupations
Transportation and Material Moving	Supervisors, transportation and material moving workers Air transportation workers Motor vehicle operators Rail transportation workers Water transportation workers Other transportation workers Material moving workers

Adapted from IPUMS NHIS (2025b, 2025c).

Appendix C. Description of Control Variables

Apart from *family history of diabetes*, X'_i includes controls on individual's *sex*, and *race*, in addition to *age*, *family size*, *education*, *region*, and *year* fixed effects, depending on the specification. Table X outlines the list of control variable and applicable specifications.

Table 9. List of control variables.

Control variables	Description	Specification outcome(s) used for
Family history of diabetes	Dummy variable indicating whether an individual has a blood related parent or sibling who has ever been told by a doctor or other health professional that they have sugar diabetes or diabetes.	All
Having aT1D at different ages		
Having aT1D & aged 18-24	Dummy variable indicating that an individual has aT1D and is aged 18-24.	Employment, work hours and above median earnings during life cycle
Having aT1D & aged 25-34	Dummy variable indicating that an individual has aT1D and is aged 25-34.	Employment, work hours and above median earnings during life cycle
Having aT1D & aged 35-44	Dummy variable indicating that an individual has aT1D and is aged 35-44.	Employment, work hours and above median earnings during life cycle
Having aT1D & aged 45-54	Dummy variable indicating that an individual has aT1D and is aged 45-54.	Employment, work hours and above median earnings during life cycle
Having aT1D & aged 55-64	Dummy variable indicating that an individual has aT1D and is aged 55-64.	Employment, work hours and above median earnings during life cycle
Female	Dummy variable indicating whether an individual is female.	All
Age		All
Age < 25 years	Dummy variable indicating that an individual is below 25 years of age.	All
Age 45–54 years	Dummy variable indicating that an individual is between 45 and 54 years of age.	All
Age > 54 years	Dummy variable indicating that an individual is above 54 years of age.	All
Race		
White	Dummy variable indicating whether an individual is White only.	All
Black	Dummy variable indicating whether an individual is Black/African American only.	All
Asian	Dummy variable indicating whether an individual is Asian only.	All
Hispanic	Dummy variable indicating whether an individual is of Hispanic ethnicity, such as Mexican, Mexican American, Puerto Rican, Cuban/Cuban American, Dominican (Republic), Central or South American, other Latin American or Spanish, or multiple Hispanic.	All
Other race	Dummy variable indicating whether an individual is non-White, non-Black/African American, and non-Asian only. Individuals may be considered multiple race, American Indian/Alaska Native only, or any other race.	All

Adapted from IPUMS NHIS (2025d).

Table 9 (continued). List of control variables.

Control variables	Description	Specification outcome(s) used for
Family size		
1, 2, 3, 4, 5, or 6+	Categorical variable indicating the number of persons in a family, considering both adults and children. The variable is top coded at 6+, meaning the maximum number of each is 3+. A family size of 1 (single adult) is omitted in the outputs due to collinearity.	All
Regional fixed effects		
Northeast, North Central/Midwest, South or West	Categorical variable indicating the U.S. region of the location of the housing unit of the individual, either Northeast, North Central/Midwest, South and West. Northeast is omitted in the output due to collinearity. The specific regions include: - Northeast: New England Division (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) and Middle Atlantic Division (New York, New Jersey, and Pennsylvania); - North Central/Midwest: East North Central Division (Michigan, Ohio, Indiana, Illinois, Wisconsin) and West North Central Division (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska); - South: South Atlantic Division (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida), East South Central Division (Kentucky, Tennessee, Mississippi, and Alabama), and West South Central Division (Texas, Arkansas, Oklahoma, and Louisiana); and - West: Pacific Division (Washington, Alaska, Oregon, California, and Hawaii) and Mountain Division (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada).	Above median earnings, including during life-cycle
Central, Fringe, Small or Non-Metro	Categorical variable indicating the county in which an individual is living. Counties are classified as: - Large central metro: counties in metropolitan statistical areas (MSAs) with a population of 1 million or more that contain the entire population of the largest principal city, that have their entire population in the largest principal city, or contain at least 250,000 inhabitants of any principal city of the MSA; - Large fringe metro: counties in MSAs with a population of 1 million or more that do not qualify as large central metro counties; - Medium and small metro: counties in MSAs with a population of less than 1 million; and - Non-metropolitan: counties that are not in an MSA. The variable is omitted in all outputs in favor of the interaction variable of it with the U.S. regions.	None

Adapted from IPUMS NHIS (2025d).

Table 9 (continued). List of control variables.

Control variables	Description	Specification outcome(s) used for
Regional fixed effects		
Northeast Central	Interaction dummy variable indicating that an individual is living both Northeast and in a large central metro county. In all specifications which include these interaction dummies, Northeast Central is omitted due to collinearity.	None
Northeast Fringe	Interaction dummy variable indicating that an individual is living both Northeast and in a large fringe metro county.	All, excl. above median earnings
Northeast Small	Interaction dummy variable indicating that an individual is living both Northeast and in a medium or small metro county.	All, excl. above median earnings
Northeast Non-Metro	Interaction dummy variable indicating that an individual is living both Northeast and in a non-metropolitan county.	All, excl. above median earnings
North Central/Midwest Central	Interaction dummy variable indicating that an individual is living both North Central/Midwest and in a large central metro county.	All, excl. above median earnings
Midwest Fringe	Interaction dummy variable indicating that an individual is living both North Central/Midwest and in a large fringe metro county.	All, excl. above median earnings
North Central/Midwest Small	Interaction dummy variable indicating that an individual is living both North Central/Midwest and in a medium or small metro county.	All, excl. above median earnings
North Central/Midwest Non-Metro	Interaction dummy variable indicating that an individual is living both North Central/Midwest and in a non-metropolitan county.	All, excl. above median earnings
South Central	Interaction dummy variable indicating that an individual is living both South and in a large central metro county.	All, excl. above median earnings
South Fringe	Interaction dummy variable indicating that an individual is living both South and in a large fringe metro county.	All, excl. above median earnings
South Small	Interaction dummy variable indicating that an individual is living both South and in a medium or small metro county.	All, excl. above median earnings
South Non-Metro	Interaction dummy variable indicating that an individual is living both South and in a non-metropolitan county.	All, excl. above median earnings
West Central	Interaction dummy variable indicating that an individual is living both West and in a large central metro county.	All, excl. above median earnings
West Fringe	Interaction dummy variable indicating that an individual is living both West and in a large fringe metro county.	All, excl. above median earnings
West Small	Interaction dummy variable indicating that an individual is living both West and in a medium or small metro county.	All, excl. above median earnings
West Non-Metro	Interaction dummy variable indicating that an individual is living both West and in a non-metropolitan county.	All, excl. above median earnings

Adapted from IPUMS NHIS (2025d).

Appendix D. Robustness Regression Outputs for the Main Specifications

The robustness tests confirm the findings for the main specifications, including the outcomes for *college entry*, *employment* and *above median earnings*. Table X reports the logistic regression results for the variables. Having aT1D is significantly negatively correlated to entering college, being employed and getting above median earnings in the sample. Additionally, having a family history of diabetes is significantly adversely related to the dependent variables, corresponding to the OLS results of the study. Thus, the main results are robust to alternate specifications.

Table 10. Robustness of educational attainment, employment and earnings effects of having aT1D.

	(1) College entry	(2) Employment	(3) Above Median Earnings within the sample
Having aT1D	-.2809**	-.5086***	-.4394***
	(.1335)	(.1607)	(.1389)
Family history of diabetes	-.1952***	-.1578***	-.0822***
	(.0397)	(.0391)	(.0282)
Female	.2571***	-.5286***	-.7908***
	(.0341)	(.0535)	(.0304)
Age			
Age < 25 years	-.8473***	-.8011***	-2.583***
	(.2157)	(.2071)	(.4740)
Age 45–54 years	-.3032***	-.2187***	.3102***
	(.0615)	(.0815)	(.0911)
Age > 54 years	-.5760***	-1.1047***	.1144
	(.0529)	(.1374)	(.0971)
Race			
White	.7534***	.0340	.3769***
	(.1037)	(.0960)	(.1222)
Black	.1057	-.4457***	-.2274*
	(1231)	(.0992)	(.1296)
Asian	1.0316***	-.1730	.4668***
	(.1306)	(.1280)	(.1454)
Hispanic	-.9113***	-.1289**	-.7903***
	(.0681)	(.0653)	(.0530)
Other race	.5049***	-.4180***	-.1356
		(.1230)	(.0852)
Family size			
2	-.1920***	.0571	.0339
	(.0495)	(.0450)	(.0385)
3	-.2296***	.0410	-.0964**
	(.0728)	(.0798)	(.0505)
4	-.1924**	-.0030	.0771
	(.0927)	(.0887)	(.0647)
5	-.4057***	-.3650***	-.0932
	(.1161)	(.1068)	(.0711)
6+	-.9659***	-.5104***	-.3157***
	(.1248)	(.1838)	(.0872)
Regional fixed effects			
Northeast Fringe	-.0361	.0627	
	(.1160)	(.1067)	

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10 (continued). Robustness of educational attainment, employment and earnings effects of having aT1D.

	(1) College entry	(2) Employment	(3) Above Median Earnings within the sample
Regional fixed effects			
Northeast Small	-.4034***	-.0900	
	(.1102)	(.0924)	
Northeast Non-Metro	-.5948***	-.1839	
	(.1594)	(.1557)	
North Central/Midwest	.1929**	-.0335	
Central	(.0994)	(.1065)	
North Central/Midwest Fringe	.0205	.1238	
	(.1014)	(.1002)	
North Central/Midwest Small	-.3652***	.1016	
	(.0913)	(.1032)	
North Central/Midwest Non-	-.8730***	-.06714	
Metro	(.1163)	(.1117)	
South Central	.2279**	.0645	
	(.0891)	(.0946)	
South Fringe	.1561*	.0610	
	(.0943)	(.1014)	
South Small	-.4400***	-.2478***	
	(.0781)	(.0834)	
South Non-Metro	-1.0565***	-.5405***	
	(.1032)	(.1004)	
West Central	.3317***	-.0808	
	(.0811)	(.0806)	
West Fringe	.3187***	.1018	
	(.1168)	(.0948)	
West Small	-.0931	-.2119**	
	(.0877)	(.0973)	
West Non-Metro	-.4664***	-.0060	
	(.1436)	(.1181)	
North Central/Midwest			-.2172***
			(.0586)
South			-.1543***
			(.0502)
West			-.0220
			(-.0651)
Year			
2017			.0684
			(.0710)
Year and regional fixed effects			
2017 and North Central/Midwest			.0618
			(.0882)
2017 and South			.0571
			(.0843)
2017 and West			.0094
			(.0844)
Constant	.9900***	2.0955***	.6314***
	(.1480)	(.1200)	(.1300)
Pseudo R^2	0.0769	0.0589	0.1274
Number of observations	20,305	20,305	29,110

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix E. Regression Outputs for the Results

Table 11. Educational attainment and employment effects of having aT1D, including controls.

	(1) High school	(2) College entry	(3) Employment
Having aT1D	-.0428	-.0606**	-.1019***
	(.0257)	(.0283)	(.0325)
Family history of diabetes	-.0094**	-.0375***	-.0282***
	(.0043)	(.0077)	(.0074)
Female	.0103***	.0488***	-.0907***
	(.0034)	(.0062)	(.0071)
Age			
Age < 25 years	-.0348	-.1671***	-.1383***
	(.0325)	(.0480)	(.0433)
Age 45–54 years	-.0193***	-.0534***	-.0319**
	(.0062)	(.0112)	(.0127)
Age > 54 years	-.0439***	-.1064***	-.2028***
	(.0052)	(.0093)	(-.0301)
Age 25–35			
Race			
White	.1084***	.1716***	.0066
	(.0176)	(.0238)	(.0168)
Black	.0600***	.0438	-.0824***
	(.0181)	(.0276)	(.0180)
Asian	.0898***	.2063***	-.0284
	(.0176)	(.0256)	(.0220)
Hispanic	-.1236***	-.1842***	-.0218*
	(.0199)	(.0133)	(.0110)
Other race	.0945***	.1227***	-.0778***
	(.0945)	(.0275)	(.0231)
Family size			
2	0060	-.0354***	.0113
	(.0053)	(.0092)	(.0081)
3	-.0062	-.0408***	.0093
	(.0062)	(.0132)	(.0137)
4	-.0186*	-.0338**	.0019
	(.0097)	(.0162)	(.0143)
5	-.0529***	-.0737***	-.0586***
	(.0113)	(.0219)	(.0183)
6+	-.1203***	-.1954***	-.0920**
	(.0192)	(.0254)	(.0359)
Regional fixed effects			
Northeast Fringe	.0148*	-.0046	.0119
	(.0087)	(.0206)	(.0179)
Northeast Small	.0036	-.0752***	-.0132
	(.0086)	(.0206)	(.0159)
Northeast Non-Metro	-.0050	-.1142	-.0310
	(.0146)	(.0329)	(.0276)
North Central/Midwest Central	-.0121	.0331*	-.0048
	(.0099)	(.0169)	(.0179)
North Central/Midwest Fringe	.0087	.0053	.0206
	(.0095)	(.0177)	(.0164)
North Central/Midwest Small	-.0111	-.0664***	.0171
	(.0092)	(.0162)	(.0168)
North Central/Midwest Non-Metro	-.0507***	-.1775***	-.0102
	(.0120)	(.0232)	(.0191)
South Central	.0091	.0422**	.0120
	(.0083)	(.0159)	(.0160)
South Fringe	.0096	.0298*	.0119
	(.0081)	(.0166)	(.0170)

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 11 (continued). Educational attainment and employment effects of having aT1D, including controls.

	(1) High school	(2) College entry	(3) Employment
North Central/Midwest Fringe	.0087	.0053	.0206
	(.0095)	(.0177)	(.0164)
North Central/Midwest Small	-.0111	-.0664***	.0171
	(.0092)	(.0162)	(.0168)
North Central/Midwest Non-Metro	-.0507***	-.1775***	-.0102
	(.0120)	(.0232)	(.0191)
South Central	.0091	.0422**	.0120
	(.0083)	(.0159)	(.0160)
South Fringe	.0096	.0298*	.0119
	(.0081)	(.0166)	(.0170)
South Small	-.0301***	-.0861***	-.0438***
	(.0086)	(.0138)	(.0146)
South Non-Metro	-.0838***	-.2264***	-.1049***
	(.0132)	(.0211)	(.0196)
West Central	.0085	.0564***	-.0134
	(.0081)	(.0145)	(.0136)
West Fringe	.0082	.0536***	.0172
	(.0132)	(.0195)	(.0157)
West Small	-.0149	-.0162	-.0354**
	(.0104)	(.0157)	(.0170)
West Non-Metro	-.0155	-.0887***	.0005
	(.0117)	(.0282)	(.0203)
Constant	.8897***	.6886***	.9080***
	(.0190)	(.0301)	(.0325)
R^2	0.0799	0.0928	0.0657
Number of observations	20,305	20,305	20,305

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 12. Occupational penalty effects of having aT1D, including controls.

	(1) High-Skill Occupations	(2) Management	(3) Business & Finance	(4) Computer & Mathemati-cal	(5) Legal	(6) Science
Having aT1D	-.0258	.0045	-.0181	.0050	.0042	.0100
	(.0315)	(.0213)	(.0130)	(.0138)	(.0082)	(.0110)
Family history of diabetes	-.0324***	-.0137***	-.0089**	-.0003	-.0044***	-.0023
	(-.0060)	(.0046)	(.0033)	(.0030)	(.0012)	(.0015)
Female	-.0502***	-.0369***	.0069*	-.0417***	-.0004	.0011
	(.0078)	(.0048)	(.0034)	(.0029)	(.0018)	(.0017)
Age						
Age < 25 years	-.1811***	-.0661***	-.0398***	-.0316***	-.0085***	-.0008
	(.0336)	(.0078)	(.0087)	(.0074)	(.0022)	(.0032)
Age 45–54 years	-.0337***	.0176**	-.0099*	-.0207***	-.0002	-.0041*
	(.0099)	(.0072)	(.0050)	(.0033)	(-.0025)	(.0020)
Age > 54 years	-.1121***	-.0061	-.0227***	-.0282***	-.0049**	-.0084***
	(.0148)	(.0086)	(.0040)	(.0037)	(.0021)	(.0024)
Race						
White	.1078***	.0343***	.0231**	.0066	-.0002	.0025
	(.0156)	(.0100)	(.0088)	(.0054)	(.0022)	(.0031)
Black	-.0527***	-.0227*	-.0014	-.0108**	-.0065**	-.0029
	(.0154)	(.0116)	(.0094)	(.0057)	(.0028)	(.0039)
Asian	.1592***	.0074	.0195*	.0885***	-.0042	.0152**
	(.0178)	(.0125)	(.0109)	(.0108)	(.0045)	(.0057)
Hispanic	-.1232***	-.0341***	-.0134**	-.0249***	-.0112***	-.0061**
	(.0113)	(.0077)	(.0058)	(.0040)	(.0023)	(.0025)
Other race	.0439*	-.0077	.0307**	.0045	-.0064**	.0025
	(.0249)	(.0153)	(.0130)	(.0084)	(.0029)	(.0046)
Family size						
2	-.0019	.0133**	-.0049	-.0024	-.0063**	-.0046
	(.0097)	(.0056)	(.0057)	(.0042)	(.0023)	(.0028)
3	-.0311*	.0080	-.0125**	-.0091*	-.0053**	-.0073**
	(.0167)	(.0070)	(.0054)	(.0047)	(.0023)	(.0030)
4	-.0066	.0189**	-.0089	-.0109**	-.0015	-.0109***
	(.0187)	(.0081)	(.0057)	(.0050)	(.0031)	(.0032)
5	-.0607***	.0069	-.0281***	-.0174***	-.0070***	-.0077*
	(.0204)	(.0100)	(.0084)	(.0059)	(.0025)	(.0045)
6+	-.1318	-.0203	-.0233*	-.0109	-.0098**	-.0147***
	(.0257)	(.0149)	(.0123)	(.0134)	(.0042)	(.0041)
Regional fixed effects						
Northeast Fringe	-.0438**	-.0215**	-.0033	.0047	-.0080	-.0022
	(.0206)	(.0106)	(.0109)	(.0086)	(.0050)	(.0040)
Northeast Small	-.1017***	-.0315***	-.0380***	-.0073	-.0114**	-.0016
	(.0211)	(.0114)	(.0100)	(.0081)	(.0055)	(.0059)
Northeast Non-Metro	-.1657***	-.0154	-.0592***	-.0136	-.0009	-.0057
	(.0334)	(.0215)	(.0137)	(.0133)	(.0082)	(.0074)
North Central/Midwest	-.0070	-.0008	.0127	.0012	-.0031	-.0018
Central	(.0212)	(.0130)	(.0116)	(.0085)	(.0058)	(.0057)
North Central/Midwest	-.0595**	-.0075	-.0141	.0160*	-.0124**	-.0068
Fringe	(.0228)	(.0137)	(.0106)	(.0094)	(.0050)	(.0052)
North Central/Midwest	-.1064***	-.0162	-.0472***	-.0047	-.0159***	-.0071
Small	(.0198)	(.0115)	(.0091)	(.0093)	(.0045)	(.0049)
North Central/Midwest	-.1871***	-.0354***	-.0493***	-.0216***	-.0181***	-.0157***
Non-Metro	(.0245)	(.0125)	(.0095)	(.0076)	(.0046)	(.0048)
South Central	.0228	.0159	-.0036	.0197**	.0061	-.0047
	(.0212)	(.0113)	(.0097)	(.0088)	(.0062)	(.0047)
South Fringe	-.0232	-.0080	.0017	.0180*	-.0096*	-.0001
	(.0187)	(.0112)	(.0095)	(.0090)	(.0054)	(.0051)
South Small	-.1340***	-.0271**	-.0427***	-.1200	-.0123**	-.0101**
	(.0184)	(.0115)	(.0082)	(.0073)	(.0051)	(.0044)
South Non-Metro	-.2185***	-.0487***	-.0630***	-.0258***	-.0163***	-.0132***
	(.0202)	(.0112)	(.0094)	(.0079)	(.0050)	(.0042)

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 12 (continued). Occupational penalty effects of having aT1D, including controls.

	(1) High-Skill Occupations	(2) Management	(3) Business & Finance	(4) Computer & Mathemati-cal	(5) Legal	(6) Science
West Central	-.0101	.0026	-.0170*	.0192**	.0013	-.0040
	(.0196)	(.0105)	(.0100)	(.0084)	(.0050)	(.0048)
West Fringe	-.0259	.0002	-.0089	.0110	-.0085	-.0046
	(.0217)	(.0161)	(.0121)	(.0085)	(.0060)	(.0058)
West Small	-.1176***	-.0149	-.0383***	-.0198***	-.0130***	-.0020
	(.0188)	(.0114)	(.0089)	(.0072)	(.0045)	(.0058)
West Non-Metro	-.1245***	-.0102	-.0407***	-.0262***	-.0129**	-.0073
	(.0334)	(.0198)	(.0127)	(.0080)	(.0060)	(.0060)
Constant	.4232***	.1118***	.0847***	.0764***	.0292***	.0245***
	(.0237)	(.0137)	(.0130)	(.0082)	(.0082)	(.0052)
R^2	0.0710	0.0187	0.0142	0.0399	0.0080	0.0053
Number of observations	20,030	20,030	20,030	20,030	20,030	20,030

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13. Occupational selection effects of having aT1D, including controls.

	(1) Physically Demanding Occupations	(2) Services	(3) Cleaning & Maintenance	(4) Construction & Extraction	(5) Farming	(6) Military
Having aT1D	-.0629*	.0046	-.0186*	-.0225**	-.0054***	-.0009***
	(.0314)	(.0216)	(.0093)	(.0092)	(.0009)	(.0003)
Family history of diabetes	-.0013	.0024	-.0001	-.0034	.0002	-.0000
	(.0056)	(.0037)	(.0017)	(.0031)	(.0011)	(.0004)
Female	-.2008***	.0320***	-.0066**	-.0713***	-.0047***	-.0011**
	(.0081)	(.0043)	(.0027)	(.0036)	(.0009)	(.0004)
Age						
Age < 25 years	.1352***	.0863***	-.0066	-.0089	.0032	-.0001
	(.0254)	(.0178)	(.0041)	(.0067)	(.0027)	(.0009)
Age 45–54 years	.0108	-.0222***	.0089**	.0075*	-.0013	-.0011**
	(.0077)	(.0049)	(.0036)	(.0039)	(.0009)	(.0004)
Age > 54 years	-.0232**	-.0379***	.0075**	-.0088**	-.0003	-.0007
	(.0093)	(.0050)	(.0037)	(.0035)	(.0013)	(.0006)
Race						
White	-.1084***	.0021	-.0335***	-.0286**	-.0105***	-.0003
	(.0223)	(.0134)	(.0113)	(.0117)	(.0039)	(.0005)
Black	-.0363	.0223*	-.0186	-.0453***	-.0105***	-.0000
	(.0224)	(.0128)	(.0122)	(.0124)	(.0038)	(.0006)
Asian	-.1557***	-.0014	-.0343***	-.0539***	-.0107***	.0002
	(.0202)	(.0150)	(.0120)	(.0122)	(.0039)	(.0007)
Hispanic	.1450***	.0252***	.0376***	.0306***	.0038*	.0016
	(.0119)	(.0091)	(.0064)	(.0056)	(.0020)	(.0014)
Other race	-.0752***	.0226	-.0228	-.0283**	-.0126***	-.0008*
	(.0257)	(.0168)	(.0136)	(.0124)	(.0044)	(.0004)
Family size						
2	.0032	-.0007	.0034	.0030	-.0012	-.0003
	(.0057)	(.0047)	(.0027)	(.0027)	(.0011)	(.0005)
3	.0316***	.0027	.0073**	.0051*	.0003	-.0000
	(.0092)	(.0054)	(.0034)	(.0028)	(.0012)	(.0006)
4	.0091	.0038	.0010	.0055	-.0016	.0002
	(.0114)	(.0069)	(.0033)	(.0044)	(.0014)	(.0008)
5	.0359**	-.0052	.0063	.0128**	.0030	.0016
	(.0140)	(.0091)	(.0044)	(.0058)	(.0027)	(.0014)
6+	.0815***	-.0105	.0423	.0200	-.0026	-.0008*
	(.0246)	(.0167)	(.0128)	(.0135)	(.0035)	(.0004)
Regional fixed effects						
Northeast Fringe	.0433**	.0015	.0031	.0050	.0021*	.0008
	(.0167)	(.0130)	(.0055)	(.0063)	(.0011)	(.0009)
Northeast Small	.0585***	.0144	.0011	-.0047	.0062***	.0000
	(.0196)	(.0127)	(.0059)	(.0056)	(.0023)	(.0002)
Northeast Non-Metro	.0737**	.0033	.0090	.0016	.0093*	.0001
	(.0309)	(.0196)	(.0104)	(.0128)	(.0053)	(.0003)
North Central/Midwest Central	.0119	-.0009	.000	-.0133**	.0012	-.0001
	(.0195)	(.0122)	(.0059)	(.0057)	(.0010)	(.0001)
North Central/Midwest Fringe	.0586***	-.0133	.0097*	.0045	.0018**	-.0000
	(.0161)	(.0123)	(.0056)	(.0063)	(.0009)	(.0002)
North Central/Midwest Small	.0867***	.0009	.0060	-.0001	.0058***	-.0001
	(.0169)	(.0105)	(.0067)	(.0068)	(.0018)	(.0002)
North Central/Midwest Non-Metro	.1805***	.0085	.0158**	.0177**	.0257***	.0021
	(.0219)	(.0162)	(.0066)	(.0081)	(.0054)	(.0014)
South Central	.0080	-.0164	-.0032	-.0044	.0013	.0016
	(.0159)	(.0107)	(.0061)	(.0057)	(.0010)	(.0012)
South Fringe	.0334*	.0089	.0077	-.0004	.0017**	.0018*
	(.0172)	(.0132)	(.0060)	(.0057)	(.0008)	(.0010)
South Small	.0874***	.0017	.0088	.0220***	.0024**	.0012*
	(.0159)	(.0117)	(.0058)	(.0059)	(.0009)	(.0007)
South Non-Metro	.1328***	-.0029	.0129*	.0095	.0105***	.0011
	(.0199)	(.0135)	(.0074)	(.0081)	(.0032)	(.0011)

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13 (continued). Occupational selection effects of having aT1D, including controls.

	(1) Physically Demanding Occupations	(2) Services	(3) Cleaning & Maintenance	(4) Construction & Extraction	(5) Farming	(6) Military
West Central	.0104	.0068	-.0015	-.0035	-.0010**	-.0001
	(.0135)	(.0132)	(.0061)	(.0057)	(.0005)	(.0002)
West Fringe	.0323	.0054	.0018	.0009	.0012	-.0000
	(.0203)	(.0137)	(.0080)	(.0081)	(.0016)	(.0002)
West Small	.0700***	.0153	.0118	.0071	.0100***	.0017
	(.0169)	(.0107)	(.0076)	(.0069)	(.0022)	(.0010)
West Non-Metro	.0846***	.0065	.0220**	.0069	.0131**	.0042
	(.0238)	(.0160)	(.0099)	(.0079)	(.0049)	(.0029)
Constant	.3587***	.0653***	.0426	.0966***	.0121***	.0009
	(.0314)	(.0143)	(.0129)	(.0142)	(.0009)	(.0013)
R^2	0.0987	0.0194	0.0164	0.0480	0.0125	0.0019
Number of observations	20,030	20,030	20,030	20,030	20,030	20,030

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 14. Work productivity effects of having aT1D, including controls.

	(1) Work Hours in the last week or in the past 2 weeks at all/main jobs/businesses	(2) Above Median Earnings within the sample
Having aT1D	-4.05**	-.0958***
	(1.57)	(.0305)
Family history of diabetes	-1.15***	-.0184***
	(0.41)	(.0059)
Female	-7.36***	-.1683***
	(0.37)	(.0075)
Age		
Age < 25 years	-10.11***	-.4621***
	(2.57)	(.0468)
Age 45–54 years	-0.63	.0701***
	(0.59)	(.0206)
Age > 54 years	-9.61***	.0283
	(1.50)	(.0219)
Race		
White	0.89	.0801***
	(0.74)	(.0257)
Black	-2.88***	-.0486*
	(0.94)	(.0264)
Asian	-1.64	.0988***
	(0.98)	(.0308)
Hispanic	-1.07**	-.1678***
	(0.52)	(.0138)
Other race	-2.63**	-.0233
	(1.17)	(.0167)
Family size		
2	0.24	.0097
	(0.48)	(.0083)
3	-0.26	-.0191*
	(0.74)	.0109
4	-0.24	.0188
	(0.71)	(.0134)
5	-3.25***	-.0191
	(0.95)	(.0154)
6+	-4.21***	-.0653***
	(1.49)	(.0192)
Regional fixed effects		
Northeast Fringe	0.11	
	(1.00)	
Northeast Small	-1.16	
	(0.86)	
Northeast Non-Metro	-1.65	
	(1.48)	
North Central/Midwest Central	-0.26	
	(0.91)	
North Central/Midwest Fringe	0.14	
	(0.95)	
North Central/Midwest Small	0.94	
	(0.90)	
North Central/Midwest Non-Metro	0.49	
	(0.85)	
South Central	0.80	
	(0.84)	
South Fringe	0.94	
	(0.94)	

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Note that year-fixed effects and a reduced version of the regional fixed effects are included in the specification in column 2, detailed in Appendix C. *** p<0.01, ** p<0.05, * p<0.1.

Table 14 (continued). Work productivity effects of having aT1D, including controls.

	(1) Work Hours in the last week or in the past 2 weeks at all/main jobs/businesses	(2) Above Median Earnings within the sample
South Small	-1.70**	
	(0.82)	
South Non-Metro	-4.00***	
	(0.98)	
West Central	-1.08	
	(0.80)	
West Fringe	-0.66	
	(1.00)	
West Small	-2.02**	
	(0.87)	
West Non-Metro	-0.15	
	(1.35)	
North Central/Midwest		-.0459***
		(.0123)
South		-.0333***
		(.0106)
West		-.0047
		(.0134)
Year		
2017		.0139
		(.0145)
Year and regional fixed effects		
2017 and North Central/Midwest		.0130
		(.0180)
2017 and South		.0130
		(.0175)
2017 and West		.0024
		(.0172)
Constant	39.63**	.6400***
	(1.57)	(.0271)
R^2	0.0819	0.1584
Number of observations	20,305	29,110

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Note that year-fixed effects and a reduced version of the regional fixed effects are included in the specification in column 2, detailed in Appendix C. *** p<0.01, ** p<0.05, * p<0.1.

Table 15. Employment and work productivity life-cycle effects of having aT1D, including controls.

	(1) Employment	(2) Work Hours in the last week or in the past 2 weeks at all/main jobs/businesses	(3) Above Median Earnings within sample
Having aT1D at different ages			
Having aT1D & aged 18-24	.0955	1.77	-.0389
	(.0875)	(4.02)	(.0710)
Having aT1D & aged 25-34	-.1423*	-6.99**	-.1107
	(.0791)	(2.75)	(.0761)
Having aT1D & aged 35-44	-.1646***	-3.74	-.1068**
	(.0576)	(3.15)	(.0454)
Having aT1D & aged 45-54	-.1208	-4.92	-.0690
	(.0740)	(3.44)	(.0512)
Having aT1D & aged 55-64	-.0754	-3.70	-.1220
	(.0478)	(2.70)	(.0787)
Family history of diabetes	-.0282***	-1.15***	-.0184***
	(.0074)	(0.41)	.0059
Female	-.0907***	-7.36***	-.1634***
	(.0071)	(0.37)	(.0075)
Age			
Age < 25 years	-.1398***	-10.15***	-.4626***
	(.0432)	(2.57)	(.0471)
Age 45–54 years	-.0320**	-0.63	.0697***
	(.0130)	(0.60)	(.0206)
Age > 54 years	-.2032***	-9.62***	.0285
	(.0301)	(1.50)	(.0219)
Race			
White	.0068	0.89	.0801***
	(.0168)	(0.74)	(.0257)
Black	-.0820***	-2.88***	-.0486*
	(.0181)	(0.94)	(.0264)
Asian	-.0281	-1.64	.0988***
	(.0220)	(0.98)	(.0308)
Hispanic	-.0216*	-1.06**	-.1678***
	(.0110)	(0.52)	(.0138)
Other race	-.0775***	-2.62**	-.0233
	(.0232)	(1.17)	(.0167)
Family size			
2	.0114	0.25	.0097
	(.0081)	(0.48)	(.0082)
3	.0093	-0.26	-.0190*
	(.0137)	(0.74)	(.0109)
4	.0022	-0.24	.0188
	(.0143)	(0.72)	(.0134)
5	-.0585***	-3.25***	-.0190
	(.0183)	(0.95)	(.0154)
6+	-.0920**	-4.21***	-.0652***
	(.0358)	(1.49)	(.0192)
Regional fixed effects			
Northeast Fringe	.0119	0.11	
	(.0179)	(1.00)	
Northeast Small	-.0134	-1.16	
	(.0159)	(0.86)	
Northeast Non-Metro	-.0311	-1.66	
	(.0276)	(1.48)	
North Central/Midwest Central	-.0048	-0.26	
	(.0179)	(0.91)	
North Central/Midwest Fringe	.0205	0.14	
	(.0164)	(0.95)	
North Central/Midwest Small	.0167	0.93	
	(.0168)	(0.91)	
North Central/Midwest Non-Metro	-.0103	0.48	
	(.0192)	(0.85)	

South Central	.0116	0.79	
	.0158(	(0.84)	
South Fringe	.0116	0.94	
	(.0170)	(0.94)	
South Small	-.0441***	-1.71**	
	(.0147)	(0.82)	
South Non-Metro	-.1054***	-4.00***	
	(.0195)	(0.98)	
West Central	-.0136	-1.08	
	(.0137)	(0.80)	
West Fringe	.0172	-0.66	
	(.0157)	(1.00)	
West Small	-.0354**	-2.01**	
	(.0170)	(0.87)	
West Non-Metro	.0004	-0.15	
	(.0204)	(1.36)	
North Central/Midwest			-.0460***
			(.0123)
South			-.0333***
			(.0106)
West			-.0047
			(.0134)
Year			
2017			
Year and regional fixed effects			
2017 and North Central/Midwest			.0130
			(.0180)
2017 and South			.0129
			(.0175)
2017 and West			.0021
			(.0171)
Constant	.9082***	39.63***	.6398***
	(.0189)	(1.05)	(.0271)
R^2	0.0659	0.0820	0.1584
Number of observations	20,305	20,305	29,110

Coefficients are rounded up to the fourth decimal point. Robust standard errors are reported in parentheses. Note that year-fixed effects and a reduced version of the regional fixed effects are included in the specification in column 3, detailed in Appendix C. *** p<0.01, ** p<0.05, * p<0.1.