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Trends in glycemic, blood pressure, and lipid control in adults with diabetes in Switzerland: the CoLaus | PsyCoLaus Study

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ABSTRACT

Aim To assess the 15-year trends in the level of glycemic, blood pressure, and cholesterol control in adults with diabetes in a Swiss population-based cohort.

Research design and methods CoLaus|PsyCoLaus is a prospective cohort study of 6733 adults aged 35–75 years in Lausanne, Switzerland. Baseline recruitment was conducted in 2003–6 and was followed by three subsequent follow-ups in 2009–12, 2014–17 and 2018–21. In adults with diabetes, glycemic control was defined as fasting plasma glucose <7 mmol/L, blood pressure control as systolic and diastolic pressures of <140/90 mm Hg, and lipid control as non-high-density lipoprotein (non-HDL) cholesterol control <3.4 mmol/L.

Results Rates of glycemic control improved from 23.2% (95% CI 19.5 to 27.3) in 2003–6 to 32.8% (95% CI 28.1 to 37.8) in 2018–21. Blood pressure control also improved, from 51.5% at baseline (95% CI 46.8 to 56.2) to 63.3% (95% CI 58.2 to 68.1) 15 years later. The largest improvement was in cholesterol control, from 29.1% (95% CI 25.1 to 33.6) in 2003–6 to 56.3% (95% CI 51.1 to 61.4) in 2018–21. Overall, simultaneous control of all three improved from 5.5% (95% CI 3.7 to 8.1) at baseline to 17.2% (95% CI 13.7 to 21.5) 15 years later. Improvements in risk factor control tallied with an increase in the use of glucose-lowering agents, blood pressure-lowering medication, and statins. Men were less likely to achieve blood pressure control but presented with a better control of non-HDL cholesterol. Caucasians were less likely to achieve simultaneous control than non-Caucasians.

Conclusion Cardiovascular risk factor control in adults with diabetes in Switzerland has increased in the last 15 years, but there remains a margin for improvement.

WHAT IS ALREADY KNOWN ON THE TOPIC

⇒ Successfully controlling glycemia, blood pressure (BP), and blood lipids reduces complications and improves health outcomes in adults with diabetes.
⇒ Through improvements in clinical care, health promotion, and education, high-income countries have successfully increased the percentage of adults achieving diabetes care targets over the last few decades.

WHAT THIS STUDY ADDS

⇒ The percentage of adults with diabetes meeting glycemic, BP, and blood lipids control targets in Switzerland increased substantially in the last 15 years.
⇒ In 2018–21, over two-thirds of patients with diabetes achieved glycated hemoglobin <7%, over 6 in 10 achieved BP <140/90 mm Hg, and over half successfully controlled their cholesterol levels; over 1 in 4 met all 3 targets simultaneously.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study can serve as a reference for public health strategies to improve diabetes risk factor control.

INTRODUCTION

Over 500 million people live with diabetes worldwide.[1] In Switzerland, national-level data on diabetes remains limited. Analysis of data from a national telephone survey reported the prevalence of self-reported diabetes was 4.8% in 2007, up from 3.3% in 1997.[2] In Lausanne, the prevalence of diabetes in adults aged 35–75 years was 6.3% in 2003–6, a third of whom were undiagnosed,[3] comparable to the 6.5% prevalence reported in Geneva.[4] This places Switzerland among the countries with the lowest diabetes prevalence in the world.[5] Nevertheless, Switzerland tops the global ranking in diabetes-related health expenditure, spending an estimated US$13 000 per adult with diabetes.[1]

The Diabetes Control and Complications Trial[6] and the United Kingdom Prospective Diabetes Study[7] established that good glycemic control in adults with diabetes reduces complications and improves health outcomes. Blood pressure[8] and blood lipid control[9] also reduces morbidity and mortality in patients with diabetes, particularly when achieved simultaneously.[10] Therefore, regular monitoring and successfully achieving glycemic, blood pressure, and blood lipid control targets are essential components in diabetes management,[11] and are included

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in the current recommendations of the Swiss Society of Endocrinology and Diabetology (SSED).[12]

Almost all patients with diabetes in Switzerland have their glycemia, blood pressure, and blood lipids levels checked at least once a year.[13] However, to our knowledge, there have been no reports on the level of simultaneous control of diabetic risk factors in Switzerland. Through improvements in clinical care, health promotion, and education, high-income countries have been successful in increasing the percentage of adults achieving diabetes care targets,[14–16] and this was linked with a decrease in diabetes-associated morbidity and mortality.[17]

Thus, the aim of the study was to report the 15-year trends in glycemic, blood pressure, and blood lipids control in participants with diabetes from a population cohort in Lausanne, Switzerland.

RESEARCH DESIGN AND METHODS

The CoLaus|PsyCoLaus Study

CoLaus|PsyCoLaus is a prospective population-based cohort study that aims to evaluate the prevalence and factors associated with cardiovascular disease in the Swiss city of Lausanne. The study has been described in detail previously.[3 18] The target population of CoLaus|PsyCoLaus during baseline recruitment was adults living in Lausanne aged 35–75 years. A list of adults living in the city in 2003 was obtained from the city's register and a simple non-stratified random sample of 35% of the city's eligible population (n=19 830) were invited to participate. Adults who agreed to participate were invited to the outpatient clinic at the Centre Hospitalier Universitaire Vaudois one morning following an overnight fast. Questionnaires documenting demographics, socio-economic status, lifestyle, personal and family medical history, and current medications were completed. This was followed by physical measurements and blood and urine biological analysis.

Participants' recruitment began in June 2003 and concluded in May 2006. The first follow-up was performed between April 2009 and September 2012, with a median follow-up time of 5.4 years (IQR 4.5–8.8). The second follow-up was performed between May 2014 and April 2017, with a median follow-up time of 10.7 years (IQR 8.8–13.6). The third follow-up was performed between April 2018 and May 2021, with a median follow-up time of 14.5 years (IQR 13.2–17.3).

Measurements

Body weight and height were measured with participants barefoot and in light indoor clothes. Body weight was measured in kilograms to the nearest 100 g using a Seca scale (Hamburg, Germany). Height was measured to the nearest 5 mm Hg using a Seca (Hamburg, Germany) height gauge. Waist circumference was measured midway between the lowest rib and the iliac crest using a non-stretchable tape and the average of two measurements was taken. Blood pressure was measured three times in a seated position using an Omron HEM-907 automated oscillometric sphygmomanometer with a minimum 10 min rest between measurements. The average of the last two blood pressure measurements was used.

Blood biological assays were performed by the Lausanne University Hospital Clinical Laboratory on fresh blood samples within 2 hours of blood collection, and additional aliquots were stored at –80°C. At baseline, all measurements were conducted using a Modular P apparatus (Roche Diagnostics, Basel, Switzerland). All measurements were conducted on a Cobas 8000 (Roche Diagnostics) during follow-ups. Glycated hemoglobin (HbA1c) levels were only assessed during the second and third follow-ups by high performance liquid chromatography using a Bio-Rad, D-10TM system.

Definitions

A participant was determined to have diabetes if they presented with a fasting plasma glucose ≥7 mmol/L and/or a current prescription for glucose-lowering medication.[3] Only participants with diabetes were included in this analysis. Diabetes awareness was defined as an affirmative answer to the question "Have you ever been told by a doctor that you have diabetes?" Glycemic control was defined as a fasting plasma glucose <7 mmol/L. Where possible, HbA1c <7% (<53 mmol/mol) was also considered.[19] Blood pressure was defined as systolic and diastolic blood pressures of <140/90 mm Hg, and a stricter <130/80 mm Hg definition was also assessed.[20] Blood lipid control was determined as non-high-density lipoprotein (non-HDL) cholesterol <3.4 mmol/L, and a second definition of low-density lipoprotein (LDL) cholesterol <2.6 mmol/L was also assessed. Simultaneous risk factor control was defined as fasting plasma glucose (FPG) <7 mmol/L, blood pressure <140/90 mm Hg and non-HDL cholesterol <3.4 mmol/L. An alternative simultaneous risk factor control analysis, with HbA1c <7% instead of FPG <7 mmol/L, was also assessed. Normal body mass index (BMI) was defined as BMI <25 kg/m^2, overweight was defined as BMI 25–29.99 kg/m^2, and obesity was defined as BMI ≥30 kg/m^2. Abdominal obesity was defined as a waist circumference >102 cm for men and >88 cm for women. Glucose-lowering medications were defined as medications with a WHO Anatomical Therapeutic Chemical (ATC) classification beginning with A10, including oral agents and insulin. Blood pressure-lowering medications were medications with ATC classifications beginning with C02, C03, C07, C08, and C09. Statins were medications with ATC classifications beginning with C10AA and C10BA.

Statistical analysis

Statistical analysis was performed on R-Studio (www.rstudio.com) and GraphPad Prism (GraphPad Software, San Diego, USA). Continuous variables were presented as median±IQR or mean±SD. Levels of glycemia, blood pressure, lipid, and simultaneous control were reported as percentages with corresponding 95% CIs. Factors

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associated with glycemic, blood pressure, non-HDL cholesterol, and simultaneous control levels were determined on all available data (combining data from baseline and all three follow-ups) through multivariate linear mixed-effects models, with the unique participant identifier set as the random effect to account for repeated measures. Models included sex, age, race, BMI category, smoking status, education level, employment status, marital status, treatment with glucose-lowering medication, treatment with blood pressure-lowering medication, and treatment with statins. As diabetes was defined as either active diabetes treatment and/or an FPG <7 mmol/L, every participant with untreated diabetes in the cohort had uncontrolled FPG. Therefore, treatment with glucose-lowering medication was not included in the glycemic control mixed effects model.

RESULTS

The number of adults with diabetes was 436 at baseline (crude prevalence 6.5%), 539 at the first follow-up (10.7%), 498 at the second follow-up (10.9%), and 383 at the third follow-up (11.4%). The number of participants who had diabetes at any stage in CoLaus was 933. The demographics and clinical characteristics of participants with diabetes can be found in table 1. Diabetes awareness increased through the course of the study, from 65.6% at baseline to 79.5% at the second follow-up and 73.7% at the third follow-up. Men were 67.4% of participants with diabetes at baseline, but the proportion decreased to 62.4% by the third follow-up. Median BMI remained stable, from 29.7 kg/m^2 at baseline to 29.2 kg/m^2 by the third follow-up.

Table 1 Characteristics of participants with diabetes in CoLaus|PsyCoLaus, Lausanne, Switzerland, 2003–21

	Baseline 2003–6	First follow-up 2009–12	Second follow-up 2014–17	Third follow-up 2018–21
All participants	6733	5064	4894	3751
People with diabetes (%)	436 (6.5)	539 (10.7)	498 (10.9)	383 (11.4)
Self-reported diabetes (%)	284 (65.6)	329 (61.0)	392 (79.5)	274 (73.7)
Treated diabetes (%)	275 (63.1)	286 (53.1)	397 (79.7)	296 (77.3)
Men (%)	294 (67.4)	371 (68.8)	320 (64.3)	239 (62.4)
Age group (years) (%)				
35–44	41 (9.4)	14 (2.6)	0 (0)	0 (0)
45–54	80 (18.3)	92 (17.1)	51 (10.2)	32 (8.4)
55–64	185 (42.4)	163 (30.2)	131 (26.3)	114 (29.8)
65–75	130 (29.8)	211 (39.1)	190 (38.2)	126 (32.9)
75+	0 (0)	59 (10.9)	126 (25.3)	111 (29.0)
Median age (IQR)	61.2 (54.0–66.2)	65.0 (56.7–70.4)	69.8 (61.3–75.1)	67.8 (62.0–76.0)
Mean age±SD	59.6±9.2	63.7±9.3	68.3±9.3	68.5±9.1
Caucasians (%)	407 (93.3)	501 (92.9)	464 (93.2)	339 (88.5)
Swiss born (%)	276 (63.3)	334 (62.0)	307 (61.6)	225 (58.7)
Married (%)	261 (68.9)	307 (65.5)	253 (60.7)	181 (56.7)
Currently working (%)	227 (52.1)	193 (36.3)	141 (30.1)	122 (32.2)
At least high school educated (%)	104 (23.9)	143 (26.6)	121 (24.3)	95 (24.8)
Current smokers (%)	106 (24.3)	110 (20.5)	84 (19.1)	55 (16.4)
BMI category (%)				
Normal weight: BMI <25 kg/m^2	73 (16.7)	71 (13.5)	52 (11.7)	49 (13.7)
Overweight: BMI 25–29.99 kg/m^2	152 (34.9)	230 (43.7)	191 (42.9)	152 (42.6)
Obese >30 kg/m^2	211 (48.4)	225 (42.8)	202 (45.4)	156 (43.7)
Median BMI (IQR)	29.7 (26.2–33.4)	29.2 (26.5–32.9)	29.5 (26.8–32.9)	29.2 (26.8–32.1)
Mean BMI±SD	30.2±5.7	30.0±5.1	30.1±4.8	29.6±4.9
Abdominal obesity (%)	273 (62.6)	357 (67.2)	317 (71.2)	253 (70.9)

Results are expressed as number of participants (percentage) for categorical variables and as mean±SD or median (IQR) for continuous variables.
BMI, body mass index.

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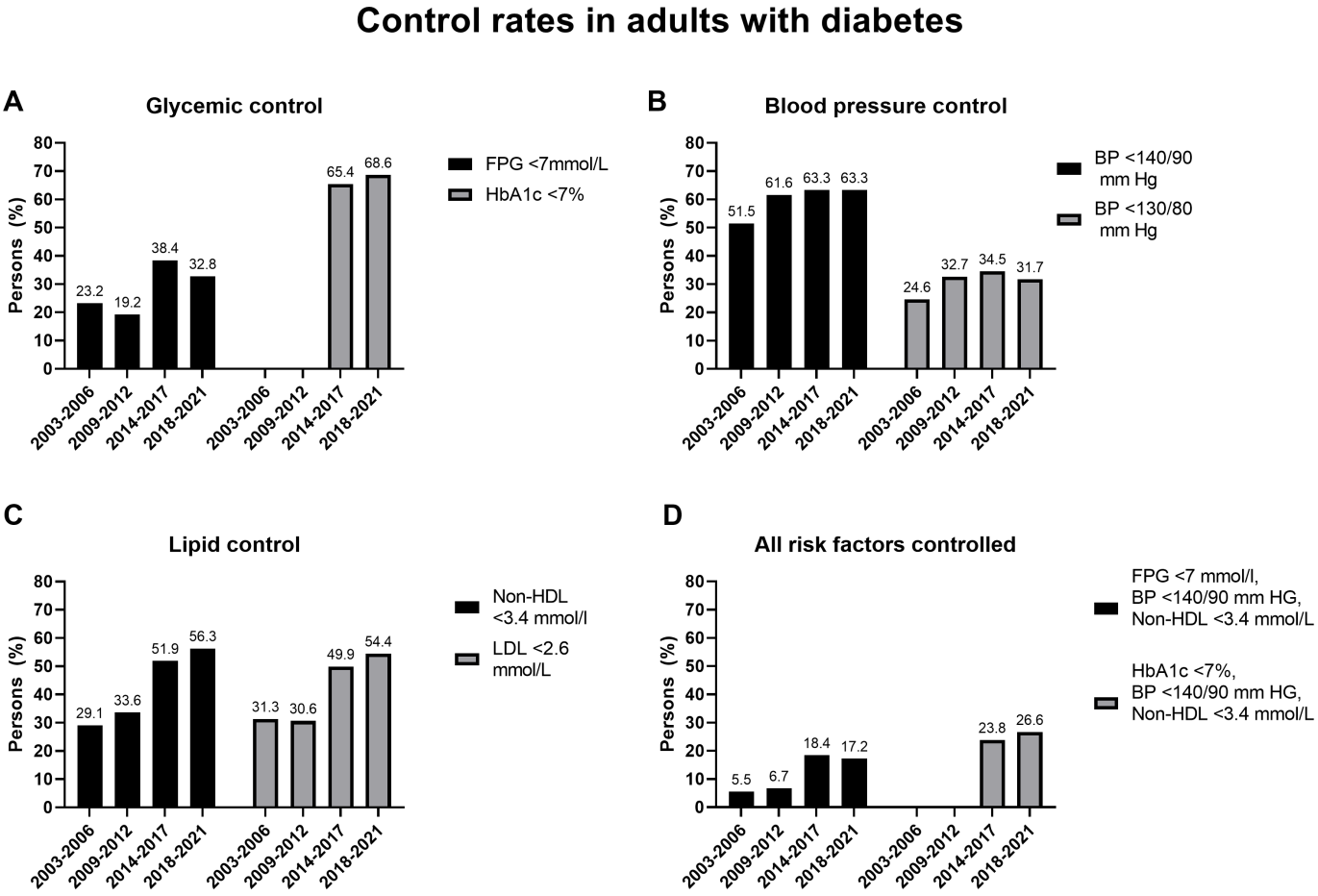

Figure 1 The percentage of adults with diabetes who achieved (A) glycemic control, (B) BP control, (C) lipid control, and (D) all risk factors controlled. CoLaus|PsyCoLaus, Lausanne, Switzerland, 2003–21. BP, blood pressure; FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

Management of cardiovascular risk factors, bivariate analysis

The percentage of adults with diabetes with an FPG <7 mmol/L was 23.2% (95% CI 19.5 to 27.3) in 2003–6 and 19.2% (16.1 to 22.8) in 2009–12 (figure 1A). This increased to 38.4% (34.0 to 42.9) in 2014–17 and was 32.8% (28.1 to 37.8) in 2018–21. HbA1c was only measured from the second follow-up. The proportion of participants with diabetes with controlled HbA1c (<7%) was 65.4% (60.9 to 69.6) in 2014–17 and 68.6% (63.3 to 73.2) in 2018–21.

The percentage of adults with diabetes with a blood pressure <140/90 mm Hg was 51.5% (95% CI 46.8 to 56.2) in 2003–6 (figure 1B). This rose to 61.6% (57.4 to 65.6), 63.3 (58.7 to 67.6), and 63.3 (58.2 to 68.1) in 2009–12, 2014–17, and 2018–21, respectively. Using a stricter blood pressure control target of <130/80 mm Hg, blood pressure control was 24.6% (20.8 to 28.9), 32.7% (28.8 to 36.7), 34.5% (30.3 to 39.0), and 31.7% (27.1 to 36.6) in 2003–6, 2009–12, 2014–17, and 2018–21, respectively.

Lipid control, as defined as non-HDL <3.4 mmol/L, was 29.1% (95% CI 25.1 to 33.6) in 2003–6 and 33.6% (28.8 to 36.7) in 2009–12 (figure 1C). This figure increased sharply to 51.9% (47.3 to 56.4) in 2014–17 and 56.3% (51.1 to 61.4) in 2018–21. Similarly, lipid control defined as LDL <2.6 mmol/L increased from 31.3% (27.1 to 35.9) in 2003–6 to 54.4% (49.2 to 59.6) in 2018–21.

Simultaneous control, defined as FPG <7 mmol/L, blood pressure <140/90 mm Hg, and non-HDL <3.4 mmol/L, was only 5.5% (95% CI 3.7 to 8.1) in 2003–6 and 6.7% (4.9 to 9.1) in 2009–12 (figure 1D) but jumped to 18.4% (15.1 to 22.3) in 2014–17 and 17.2% (13.7 to 21.5) in 2018–21. Simultaneous control defined with HbA1c <7% was only possible from 2014 onwards and was 23.8% (20.1 to 28.0) in 2014–17 and 26.6% (22.3 to 31.5) in 2018–21.

Management of cardiovascular risk factors in self-reported diabetes, bivariate analysis

Glycemic control was higher in adults who self-reported a pre-existing diagnosis of diabetes (online supplemental figure 1A). The percentage of adults with self-reported diabetes with a fasting plasma glucose <7 mmol/L was 34.8% (95% CI 29.6 to 40.5) in 2003–6, 31.3% (26.5 to 36.5) in 2009–12, 45.4% (40.3 to 50.6) in 2014–17, and 38.2% (32.3 to 44.3) in 2018–21. The percentage of adults with self-reported diabetes with a blood pressure <140/90 mm Hg was 52.4% (46.7 to 58.2) in 2003–6, 62.9% (57.6 to 68.0) in 2009–12, 63.7% (58.6 to 68.6)

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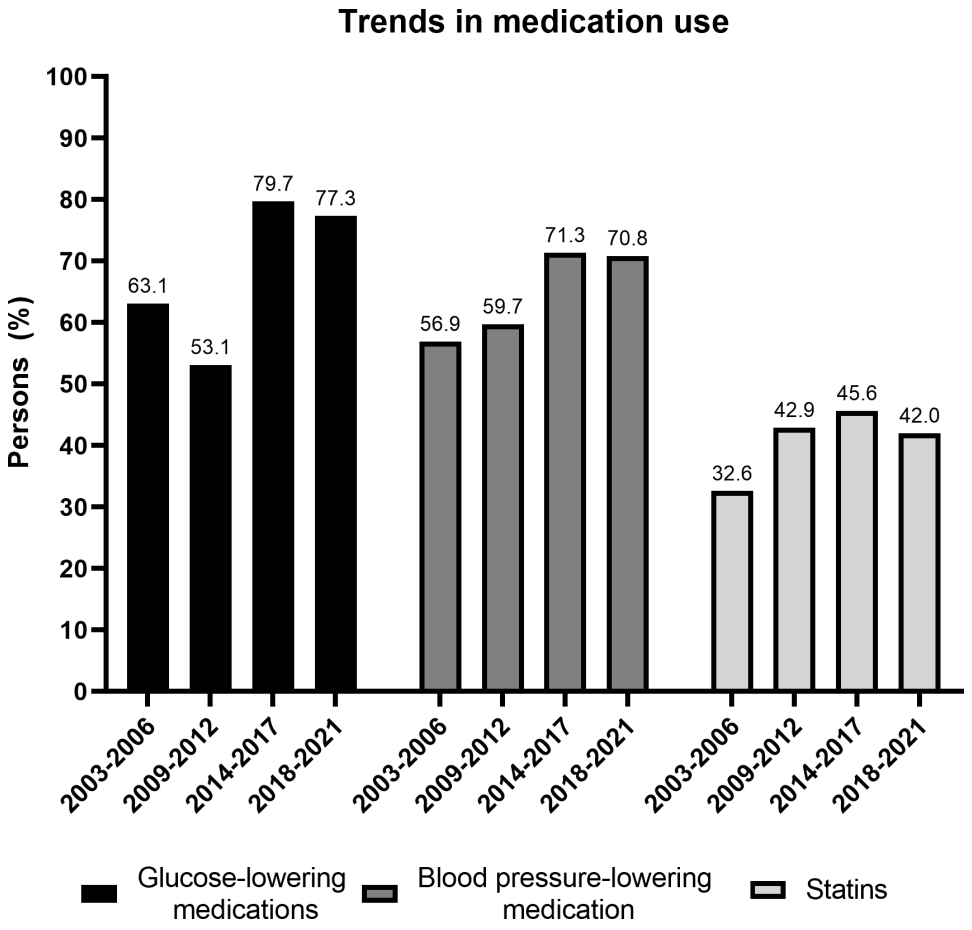

Figure 2 Trends in the use of glucose-lowering medication, blood pressure-lowering medication, and statins in adults with diabetes. CoLaus|PsyCoLaus, Lausanne, Switzerland, 2003–21.

in 2014–17, and 62.5% (56.3 to 68.2) in 2018–21 (online supplemental figure 1B). Non-HDL control in self-reported diabetes increased from 35.5% (30.2 to 41.2) in 2003–6 to 44.2% (38.9 to 49.6) in 2009–12, 56.2% (51.0 to 61.3) in 2014–17, and 60.2% (54.1 to 66.1) in 2018–21 (online supplemental figure 1C). Finally, simultaneous ABC control also increased in adults with self-reported diabetes, from 8.4% (5.7 to 12.2) in 2003–6 to 11.0% (8.1 to 14.9) in 2009–12, 21.7% (17.7 to 26.3) in 2014–17, and 19.4% (15.0 to 24.8) in 2018–21 (online supplemental figure 1D).

Trends in medication use

The proportion of adults with diabetes treated with glucose-lowering medication was only 63.1% (95% CI 58.4 to 37.5) in 2003–6, and this increased to 79.7% (83.0 to 80.0) in 2014–17 and 77.3% (72.8 to 81.2) in 2018–21 (figure 2). Likewise, participants with diabetes treated for blood pressure-lowering medication increased from 56.9% (55.5 to 63.8) in 2003–6 to 70.8% (66.0 to 75.1) 15 years later. Finally, statins were prescribed to 32.6% (28.3 to 37.1) of participants with diabetes in 2003–6, and this figure increased to 45.6% (41.3 to 50.0) in 2014–17 and 42.0% (37.2 to 47.0) in 2018–21.

Management of cardiovascular risk factors, multivariate analysis

Factors associated with glycemic, blood pressure, non-HDL cholesterol, and simultaneous control of all three were determined through a multivariate mixed model, factoring in the whole study period (2003–21) (table 2). Participants at least 65 years of age, treated with blood pressure-lowering medication, or treated with statins were more likely to have controlled fasting plasma glucose levels. Men or participants with obesity were less likely to have controlled blood pressure. Men, adults at least 65 years of age, adults treated for diabetes, or adults with statins were more likely to have controlled non-HDL cholesterol levels. In contrast, Caucasian and participants with obesity were less likely to meet the non-HDL cholesterol control target. Factors associated with simultaneous control of all three risk factors were race (Caucasian OR 0.91, 95% CI 0.85 to 0.97), treatment with glucose-lowering medication (OR 1.15, 95% CI 1.11 to 1.20) and treatment with statins (OR 1.08, 95% CI 1.05 to 1.12).

DISCUSSION

In this prospective population-based cohort, we report large improvements in levels of cardiovascular risk factor

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Table 2 Factors associated with controlled FPG, BP, non-HDL cholesterol, and simultaneous control of all three

	FPG <7 mmol/L		BP <140/90 mm Hg		Non-HDL <3.4 mmol/L		All risk factors controlled	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Male	0.95 (0.90 to 1.01)	0.09	0.91 (0.86 to 0.97)	0.005	1.08 (1.02 to 1.15)	0.007	1.00 (0.97 to 1.04)	0.93
Age ≥65 years	1.06 (1.00 to 1.13)	0.04	0.96 (0.90 to 1.02)	0.22	1.10 (1.04 to 1.16)	0.002	1.03 (0.99 to 1.07)	0.15
Caucasians	0.91 (0.82 to 1.00)	0.05	0.93 (0.83 to 1.03)	0.16	0.86 (0.78 to 0.95)	0.002	0.91 (0.85 to 0.97)	0.003
BMI ≥30 kg/m^2	0.95 (0.90 to 1.00)	0.06	0.93 (0.88 to 0.98)	0.01	0.94 (0.89 to 0.99)	0.02	0.98 (0.95 to 1.02)	0.27
Non-smokers	1.01 (0.94 to 1.07)	0.86	1.02 (0.95 to 1.09)	0.60	1.02 (0.96 to 1.09)	0.55	1.02 (0.98 to 1.07)	0.33
Married	1.00 (0.95 to 1.06)	0.96	1.07 (1.01 to 1.13)	0.03	0.98 (0.92 to 1.03)	0.37	1.00 (0.96 to 1.03)	0.80
Currently employed	0.96 (0.90 to 1.02)	0.15	1.01 (0.94 to 1.07)	0.88	0.98 (0.93 to 1.04)	0.57	1.00 (0.96 to 1.05)	0.86
At least high school education	0.97 (0.91 to 1.03)	0.29	1.05 (0.98 to 1.12)	0.20	0.99 (0.93 to 1.06)	0.86	0.99 (0.95 to 1.03)	0.58
Treated with								
Glucose-lowering medication	- -	–	1.05 (0.99 to 1.11)	0.11	1.21 (1.15 to 1.27)	<0.001	1.15 (1.11 to 1.20)	<0.001
BP-lowering medication	1.06 (1.00 to 1.11)	0.05	0.97 (0.92 to 1.03)	0.38	1.05 (1.00 to 1.11)	0.06	0.98 (0.95 to 1.02)	0.36
Statins	1.08 (1.03 to 1.14)	0.001	1.02 (0.97 to 1.08)	0.41	1.37 (1.30 to 1.44)	<0.001	1.08 (1.05 to 1.12)	<0.001

Multivariate mixed model; CoLaus|PsyCoLaus, Lausanne, Switzerland, 2003–21. Results are expressed as OR and (95% CI).
BMI, body mass index; BP, blood pressure; FPG, fasting plasma glucose; HDL, high-density lipoprotein.

control in adults with diabetes over the last 15 years in Switzerland. In 2018–21, over two-thirds of adults with diabetes achieved HbA1c <7%, over 6 in 10 achieved blood pressure <140/90 mm Hg, and over half successfully controlled their cholesterol levels. More than one in four successfully controlled all three simultaneously. The SSED criteria for good disease management for diabetes sets a target of ≥40% of patients with diabetes achieving <7% HbA1c, ≥65% achieving blood pressure <140/90 mm Hg, and ≥63% achieving an LDL cholesterol <2.6 mmol/L.[21] Despite the substantial progress of the last 15 years, our analysis shows that only the SSED HbA1c target was met in 2018–21 (68.6%). The percentage of patients with diabetes successfully controlling their blood pressure (63.3%) and LDL cholesterol (54.4%) still lags the SSED guidelines. Our results are similar to a recent analysis of nine general practices in St Gallen,[22] which reported that glycemic control was a little under 60%, and blood pressure and LDL cholesterol control was only achieved in half of the patients. In contrast, an analysis of 365 patients with type 2 diabetes at two tertiary care centers in the cities of Bern and St Gallen reported that blood pressure <140/90 mm Hg was achieved by 92% of patients with diabetes.[23] There are regional differences in diabetes and cardiovascular management in Switzerland.[24 25]

We also report that the percentage of participants with diabetes simultaneously controlling their FPG, blood pressure, and non-HDL cholesterol more than tripled during the study, from 5.5% in 2003–6 to 17.2% in 2018–21. When glycemic control was defined as HbA1c <7%, 26.6% of adults with diabetes in 2018–21 simultaneously achieved all three risk factors control targets. These improvements mirror reports in the USA, where the proportion of adults with diabetes achieving simultaneous control of glycemia, blood pressure, and blood lipids more than doubled in under two decades, from 9% in 2000 to 22.2% in 2018.[26] In Europe, a retrospective analysis of data on diabetes from eight countries (Belgium, France, Germany, Italy, Ireland, Sweden, the Netherlands, and the UK) reported simultaneous control of all three risk factors in 2010 was only 6.5%,[15] comparable to the 6.7% reported in 2009–12 in this study. It is unclear if diabetes care on the continent has improved in the last decade to the extent it has in this Swiss cohort. In India, only 7.7% of adults with diabetes achieved simultaneous targets in 2018–20,[27] and an analysis from 55 low-income countries found that fewer than 1 in 10 patients with diabetes met guideline diabetes care.[28]

The largest improvement reported in this study was in lipid control, which almost doubled from 29% to 56% in 15 years. This rose concomitantly with use of statins. A recent global analysis of pooled health data reported a decrease in non-HDL cholesterol levels in high-income Western countries, credited to increased statin use.[29] However, while glycemic control and blood pressure control rates improved in the first decade of CoLaus|PsyCoLaus, they plateaued or dropped from 2014–17 to 2018–21, as did the percentage of participants with diabetes taking glucose-lowering and blood pressure-lowering medication. These findings are consistent with a similar study in the USA,[26] which reported blood pressure and glycemic control rates stalled between 2014 and 2018, following sharp increases in the proceeding 15 years. The reason for the decrease in use of glucose-lowering and blood pressure-lowering medication is unclear. Clinical trials reported in 2008 and 2009 found that intensive glycemic control did not reduce cardiovascular events and may

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increase mortality.[30 31] A third trial reported in 2010 that intensive blood pressure control (systolic blood pressure <120 mm Hg) likewise had no cardiovascular benefit and increased the risk of a serious adverse event.[32] This may have contributed to the recent less aggressive treatment of diabetes and hypertension. Another possible contributing factor in the decrease in glycemic control, blood pressure control and medication use between 2018 and 2021 is the disruption of healthcare access and utilization caused by the COVID-19 pandemic. The USA has seen a recent resurgence in diabetes-related amputations, hospitalization, and death,[33] underscoring the importance of adhering to clinical guidelines and care targets in diabetes.

We also found race and sex differences in risk factor control rates. Men were less likely to achieve blood pressure control but were more likely to achieve non-HDL cholesterol control. Analysis from the National Health and Nutrition Examination Survey in the USA also found women with diabetes were less likely to achieve lipid control than men.[34] We also found that non-Caucasians were more likely to achieve simultaneous diabetes risk factor control than Caucasians. This is in stark contrast to the USA, were both Hispanic and African-American adults were less likely to meet any individual or combined target than non-Hispanic white adults.[34] In Kuwait, a similar study found that nationals were twice as likely to have controlled blood pressure, non-HDL cholesterol and simultaneous glycemic, blood pressure, and cholesterol control than non-Kuwaiti migrants.[35] In both the USA and Kuwait, poorer outcomes among ethnic populations were attributed to poorer utilization of care and lower socioeconomic levels. Due to Switzerland's relatively restrictive immigration policy, ethnic minorities in Switzerland are often well educated and in higher socioeconomic brackets.

Strengths and limitations

This study had several strengths and limitations. To our knowledge, this study is the first to report simultaneous risk factor control in a Swiss diabetes population. The CoLaus|PsycoLaus cohort was large, and data were collected in a rigorous and standardized manner over the course of 15 years, up to 2021. However, HbA1c was only measured from 2014 onwards and CoLaus|PsycoLaus only recruited participants in the city of Lausanne. As such, the sample might not be representative of the whole Swiss population due to local variation in cardiovascular and diabetes management.[24 25] Our results may therefore not be generalizable to other regions of Switzerland.

In conclusion, we report a substantial increase in the level of risk factor control in adults with diabetes in the city of Lausanne. More than one in four successfully controlled their glycemic, blood pressure, and blood cholesterol in 2018–21, a rate comparable with the USA and other high-income Western countries. Despite these improvements, the percentage of adults with diabetes achieving blood pressure and blood cholesterol control remains below clinical guidelines.

Contributors AA: methodology; formal analysis, investigation, writing—original draft. JV: project administration, writing—review and editing. PM-V: conceptualization, data curation, project administration, writing—review and editing. PM-V has full access to the data and is the guarantor of the study.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval The CoLaus|PsyCoLaus study was ethically approved by CER-VD (la Commission cantonale d'éthique de la recherche sur l'être humain; www.cer-vd.ch; project number PB_2018-00038, reference 239/09). The full decisions of the CER-VD can be obtained from the authors on request. The study was performed in agreement with the Helsinki Declaration and its former amendments, and in accordance with the applicable Swiss legislation. All participants provided their signed informed consent before entering the study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. The data of CoLaus|PsyCoLaus study used in this article cannot be fully shared as they contain potentially sensitive personal information on participants. According to the Ethics Committee for Research of the Canton of Vaud, sharing these data would be a violation of the Swiss legislation with respect to privacy protection. However, coded individual-level data that do not allow researchers to identify participants are available on request to researchers who meet the criteria for data sharing of the CoLaus|PsyCoLaus Datacenter (CHUV, Lausanne, Switzerland). Any researcher affiliated to a public or private research institution who complies with the CoLaus|PsyCoLaus standards can submit a research application to research.colaus@chuv.ch or research.psycolaus@chuv.ch. Proposals requiring baseline data only will be evaluated by the baseline (local) Scientific Committee (SC) of the CoLaus and PsyCoLaus studies. Proposals requiring follow-up data will be evaluated by the follow-up (multicentric) SC of the CoLaus|PsyCoLaus cohort study. Detailed instructions for gaining access to the CoLaus|PsyCoLaus data used in this study are available at www.colaus-psycolaus.ch/professionals/how-to-collaborate/.

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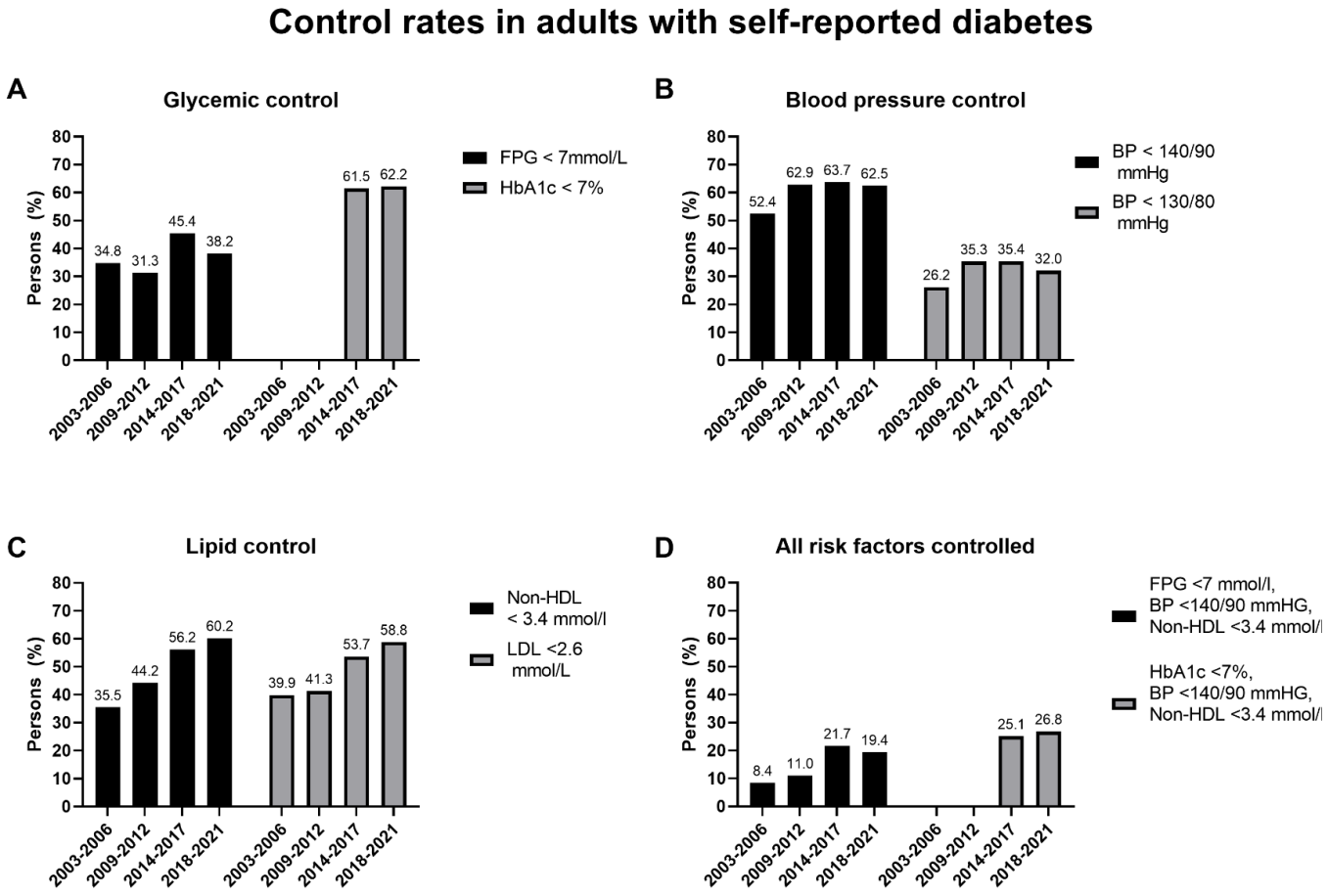

Supplementary Figure 1: The percentage of adults with self-reported diabetes who achieved (A) glycemic, (B) blood pressure, (C) lipid, and (D) all risk factor control. CoLaus|PsyCoLaus, Lausanne, Switzerland, 2003-21.