

Diabetes prevalence and metabolic risk profile in an unselected population visiting pharmacies in Switzerland

Alexandre Rey¹
Martin Thoenes^{1,2}
Rolf Fimmers³
Christoph A Meier⁴
Peter Bramlage⁵

¹Sanofi Aventis, Medical Department, Meyrin, Switzerland; ²Institute for Clinical Pharmacology, Medical Faculty Carl Gustav Carus, Technical University Dresden, Germany; ³Institut für Medizinische Biometrie, Informatik und Epidemiologie, Universität Bonn, Germany; ⁴Klinik für Innere Medizin, Stadtspital Triemli, Zürich, Switzerland; ⁵Institut für Pharmakologie und präventive Medizin, Mahlow, Germany

Background: Diabetes represents one of the major health challenges in Switzerland, and early diagnosis and treatment is mandatory to prevent or delay diabetes-related morbidity and mortality. For the purpose of identifying affected individuals, early screening in pharmacies is a valuable option. In this survey, we aimed to determine blood glucose and metabolic control in an unselected population of individuals visiting Swiss pharmacies.

Methods: The subjects responded to a short questionnaire and underwent a single capillary blood glucose test for screening purposes. They were classified as normal, indeterminate, impaired fasting glucose, and diabetes according to predefined blood glucose levels.

Results: A total of 3135 individuals (mean age 56 years) in 18 cantons were screened in November 2010; of these, 4.2% (95% confidence interval [CI] 3.5–4.9) had previously been diagnosed with diabetes. Diabetes was newly diagnosed in 1.9% (95% CI 1.5–2.4), and 11.5% (95% CI 10.4–12.6) had impaired fasting glucose. Subjects with impaired glucose control had an increased body mass index, a frequent family history of diabetes, hypertension, hypercholesterolemia, smoking, and a low level of physical activity. Prevalence of impaired glucose control was different between the French/Italian-speaking part of Switzerland (new diabetes 4.9%; impaired fasting glucose 12.7%) and the German-speaking part (new diabetes 1.9%; impaired fasting glucose 10.3%).

Conclusion: Our study shows a 6.1% prevalence of diabetes, of which about a third (1.9%) was previously undiagnosed, and 11.5% had impaired fasting glucose. Therefore, screening initiatives in pharmacies may be suitable for detecting people with undiagnosed diabetes.

Keywords: diabetes, pharmacy, epidemiology, screening

Introduction

There is an increasing prevalence of type 2 diabetes globally, which is attributable to a growing global population, an increase in life expectancy, increased diagnostic efforts, and a reduced diabetes risk attributable to recent advances in diabetes treatment.¹ Therefore, diabetes is a major driver of health care costs.²

For Switzerland, a diabetes prevalence of 3.3% has been reported for 1997 and an increase to 4.8% in the year 2007.³ Other data from a large population-based study conducted in the French part of Switzerland point to an even higher prevalence.⁴ Therefore, it is not surprising that type 2 diabetes and its complications contribute to 2.2% of Switzerland's health care expenditure.⁵

Early diagnosis and treatment is mandatory to prevent or delay diabetes-related morbidity and mortality and reduce health care costs. Within this context, measurement of blood glucose levels during screening initiatives may help to identify persons

Correspondence: Peter Bramlage
Institut für Pharmakologie und
präventive Medizin, Menzelstrasse 21,
15831 Mahlow, Germany
Tel +49 337 9314 7890
Fax +49 337 9314 7892
Email peter.bramlage@ippmed.de

with unknown diabetes or impaired fasting glucose and to initiate preventative measures or appropriate therapy in a timely manner. Pharmacies are particularly suitable for this purpose, because they are an easily accessible point of contact for individuals not visiting physicians.

Based on these considerations, we conducted a national survey in pharmacies of the AMAVITA chain documenting more than 3000 individuals with respect to their random blood glucose values and further cardiometabolic parameters. Our aim was to assess glucose values, classify observed values into normal, indeterminate, impaired fasting glucose, and definite diabetes, in a largely unselected population of pharmacy attendees.

Materials and methods

Individuals visiting a participating pharmacy in one of 18 cantons of Switzerland were enrolled into the present study. Participants were selected based on their willingness to undergo blood glucose testing and to provide information on their cardiometabolic risk profile, without any further predefined selection criteria. Patients not willing to participate were neither documented nor counted to determine participation rates.

Prior to enrollment, all study participants received a written information leaflet explaining the survey objectives and procedures. The study was conducted in accordance with applicable Swiss national regulations for epidemiologic studies and good epidemiologic practice, and informed verbal consent was obtained. A signed informed consent form was not required, because no personal data were registered and measurement of blood glucose is a standard procedure in Swiss pharmacies.

Documentation

On an anonymized one-page case report form, participants were asked to report the time of their last meal, as well as their gender, age, body weight, and height. The following parameters were also documented: presence or absence of diabetes, antidiabetic treatment, family history of diabetes or, in women, a weight of more than 4 kg of their newborns, a history of cardiovascular events (myocardial infarction, stroke), and cardiovascular risk factors (hypertension, hypercholesterolemia, smoking, physical exercise). Physical exercise was classified as no activity, moderate (at least 30 minutes/day for 5 days/week, eg, walking, dancing, gardening), or strenuous (at least 20 minutes/day on 3 days a week, eg, jogging, swimming, team sports).

Blood glucose classification

Capillary blood glucose was measured in all study participants using a uniform blood glucose monitoring device (Accu-Check® Aviva, Roche, Basel, Switzerland) according to the manufacturer's instructions. Based on their blood glucose values, study participants were categorized as either fasting (last meal ≥ 8 hours), or nonfasting (last meal < 8 hours), and were further subclassified into four different groups based on their blood glucose levels as follows: normal blood glucose (< 5.6 mmol/L for fasting/nonfasting), diabetes status indeterminate (5.6 to < 11.1 mmol/L for nonfasting), impaired fasting glucose (5.6–6.9 mmol/L for fasting), and diabetes (≥ 7 mmol/L for fasting; ≥ 11.1 mmol/L for nonfasting).

Regional analyses

For the regional analyses, cantons were subdivided into the German-speaking population (SUI-GER) which comprised the cantons Aargau, Bern, Basel-Land, Basel-Stadt, Graubünden, Luzern, St Gallen, Solothurn, Zug, and Zurich, and the French/Italian speaking population (SUI-FR/IT) comprising Fribourg, Geneva, Jura, Neuchâtel, Tessin, Waadtland, and Wallis.

Statistical analysis

We performed a descriptive analysis of the data. For this purpose, only participants with complete data regarding the individual parameters were considered. Continuous variables are shown as the mean \pm standard deviation, and categorical variables as percentages. *P* values for comparison between groups of patients were calculated using the two-sided *t*-test for quantitative variables and the χ^2 test for qualitative variables.

Results

A total of 3135 participants were enrolled by 102 pharmacies in November 2010. The study population comprised 27% males, had a mean age of 56 years and a mean body mass index of 25 kg/m². Mean random blood glucose was 6.0 ± 1.5 mmol/L, and about one quarter (23.0%) of participants were in a fasting state (Table 1). The presence of diabetes was self-reported by 131/3135 participants (4.2%; 95% confidence interval [CI] 3.5–4.9), and the majority of these known diabetic participants (67.2%) were treated with oral antidiabetic drugs alone. A total of 6.1% received an insulin-containing regimen (insulin alone or basal insulin-assisted oral antidiabetic treatment) and 24.4% received diet and exercise alone.

Table 1 Participant characteristics (total n = 3135)

	Variable available*	Total** %/mean ± SD	SUI-GER*** %/mean ± SD	SUI-FR/IT*** %/mean ± SD	P value for GER versus FR/IT
Total (n)	3135		1681	1454	
Male	2935	26.5	27.1	25.8	0.429
Age (years)	3047	56.1 ± 16.6	57.5 ± 16.5	54.6 ± 16.4	<0.001
Body weight (kg)	2997	69.4 ± 14.2	69.7 ± 14.1	69.1 ± 14.3	0.249
Body mass index (kg/m ²)	2983	24.9 ± 4.3	24.9 ± 4.2	24.9 ± 4.3	0.417
Blood glucose (mmol/L)	2989	6.0 ± 1.5	6.0 ± 1.5	6.0 ± 1.5	0.221
Fasting state	3120	23.0	19.1	27.6	<0.001
Known diabetes	3091	4.2	3.6	5.0	0.063
OAD	131	67.2	55.0	77.5	
BOT	131	2.3	3.3	1.4	
Insulin	131	6.1	10.0	2.8	
No drugs	131	24.4	31.7	18.3	
Family history of diabetes					
Father	3058	9.0	8.1	10.1	0.054
Mother	3077	13.6	13.0	14.2	0.363
High birthweight (women)	2824	7.3	8.0	6.5	0.136
Hypertension	3090	25.0	24.1	26.0	0.205
Blood pressure (mmHg)	412				
Systolic	410	138.1 ± 15.1	139.5 ± 13.9	137.0 ± 16.0	0.046
Diastolic	409	82.5 ± 10.6	82.1 ± 9.9	82.9 ± 11.2	0.091
Hypercholesterolemia	2951	16.0	14.8	17.3	0.067
Smoking	3124	17.7	15.7	20.0	0.002
Physical exercise	3003				
No/minimal	614	21.8	13.6	31.1	<0.001
Moderate	1750	58.3	62.8	53.2	
Strenuous	599	19.9	23.6	15.8	
History of myocardial infarction	3116	2.3	2.4	2.3	0.977
History of stroke	3095	1.5	1.2	1.9	0.129

Notes: *Variable available together with regional (canton) information; **variable available; ***variable available and belonging to the region.

Abbreviations: SD, standard deviation; OAD, oral antidiabetic drug; BOT, basal insulin assisted oral antidiabetic treatment; SUI-FR/IT, French/Italian-speaking part of Switzerland; SUI-GER, German speaking part of Switzerland.

Prevalence of unknown impaired glucose control

Of 3004 participants with previously unknown diabetes, 86.7% had a normal (43.2%) or indeterminate (43.5%) blood glucose status, 11.5% were diagnosed with impaired fasting glucose, and 2.0% had new diabetes. Impaired glucose control was particularly prevalent in older age ($P < 0.001$), male patients ($P = 0.011$), and those with a body mass index > 25 kg/m² ($P < 0.001$). The prevalence was also higher in participants with risk factors, such as hypertension, hypercholesterolemia, and smoking ($P < 0.001$, Table 2).

SUI-GER versus SUI-FR/IT

In the total cohort, the diabetes prevalence was 6.1% (CI 5.3–7.0, Figure 1). A total of 1681 participants were from the SUI-GER region, and 1454 participants from the SUI-FR/IT region (Table 3). Mean blood glucose levels were similar in both regions of Switzerland. In the SUI-FR/IT region,

the participants were younger ($P < 0.001$) and were more often fasting ($P < 0.001$), while the prevalence of diabetes was only nominally higher and many participants were treated with oral antidiabetic drugs compared with SUI-GER. Furthermore, participants in SUI-FR/IT had lower blood pressure values ($P = 0.046$), were more likely to be smokers ($P = 0.002$), and had a low level of physical activity ($P < 0.001$, Table 1).

The regional comparison (Table 3) showed a lower number of participants with known diabetes in the SUI-FR/IT region (5.0% versus 3.6% in SUI-GER; $P = 0.063$), whereas no regional difference was seen with regard to newly diagnosed diabetes (1.9% for both).

The frequency of a normal glucose profile varied between 30.7% (Basel-Stadt) and 52.8% (Tessin), whereas impaired fasting glucose was most frequently diagnosed in Geneva (17.2%), but in only 5% of participants in the canton of Jura. The presence of diabetes was most frequently reported

Table 2 Metabolic profile in participants

	Without known diabetes				Known diabetes	
	Total (variable available)*	Normal n (% of total)	Indeterminate n (% of total)	IFG n (% of total)	New diabetes n (% of total)	n (% of known diabetes)
Total (n; % of total)	2952	1275 (43.2)	1284 (43.5)	354 (11.5)	59 (2.0)	131 (4.2)
Fasting (n, %)	670	360 (53.7)	37 (5.5)	236 (35.2)	37 (5.5)	49 (6.9)
Nonfasting (n, %)	2376	934 (40.3)	1259 (54.3)	103 (4.4)	23 (1.0)	82 (3.5)
Age \geq median (n, %)	1426	517 (36.3)	690 (48.4)	182 (12.8)	37 (2.6)	104 (6.9)
Male gender (n, %)	723	298 (41.2)	314 (43.3)	87 (12.0)	24 (3.3)	51 (6.7)
BMI \geq 25 kg/m ² (n, %)	1204	459 (38.1)	564 (46.8)	146 (12.1)	35 (2.9)	80 (6.3)
Risk factors for DM						
Family history of DM (n, %)	583	241 (41.3)	251 (43.1)	76 (13.0)	15 (2.6)	49 (7.8)
Father (n, %)	263	117 (44.5)	105 (39.9)	36 (13.7)	5 (1.9)	13 (4.7)
Mother (n, %)	375	143 (38.1)	171 (45.6)	50 (13.3)	11 (2.9)	42 (10.2)
High birthweight (n, %)	198	77 (38.9)	97 (49.0)	20 (10.1)	4 (2.0)	7 (3.4)
Risk factors (other)						
Hypertension (n, %)	687	231 (33.6)	345 (50.2)	83 (12.1)	28 (4.1)	84 (11.1)
Hypercholesterolemia (n, %)	411	142 (34.5)	201 (48.9)	54 (13.1)	14 (3.4)	57 (12.4)
Smoking (n, %)	529	192 (36.3)	238 (45.0)	83 (15.7)	16 (3.0)	24 (4.4)
No/minimal physical exercise (n, %)	618	255 (41.3)	270 (43.7)	78 (12.6)	15 (2.4)	34 (5.3)
Cardiovascular events						
History of MI (n, %)	55	17 (30.9)	30 (54.5)	8 (14.5)	0 (0.0)	17 (23.6)
History of stroke (n, %)	40	16 (40.0)	18 (45.0)	4 (10.0)	2 (5.0)	6 (13.6)

Notes: *Variable available together with information on blood glucose classification; **comparison across normal, indeterminate, IFG, and diabetes.

Abbreviations: DM, diabetes mellitus; IFG, impaired fasting glucose; SD, standard deviation; MI, myocardial infarction.

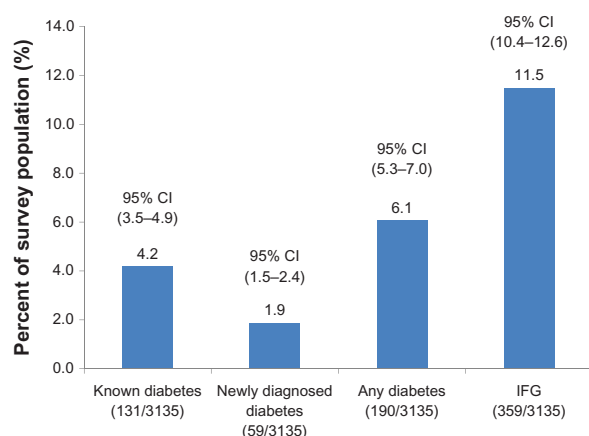


Figure 1 Prevalence of diabetes.

Abbreviations: CI, confidence interval; IFG, impaired fasting glucose.

in Geneva (8.0%) and least frequently in the canton of Jura (1%). Most cases of new diabetes were detected in the canton of Zug (6.0%), whereas the lowest number of new diabetes cases was seen in the canton of Graubünden (0.5%) and Wallis (1%). Due to low numbers of study participants, the cantons of Schaffhausen, Solothurn, and Waadtland were not considered for this comparison.

Discussion

Our analysis shows a 6.1% prevalence of diabetes in an unselected Swiss population visiting a pharmacy and

agreeing to participate in our survey, of which 4.2% had known diabetes and 1.9% were newly detected by capillary blood glucose determination. These data not only confirm a recently published prevalence of 4.8% in a population aged 18 to >65 years (nationwide, population-based telephone survey), but indicate stable prevalence of diabetes from 2007 to 2010 using a similar methodologic approach.³ However, based on the number of newly diagnosed diabetic participants in our survey, it can be assumed that the real diabetes burden in Switzerland is higher than previously reported.

Diabetes prevalence in perspective

According to the International Diabetes Federation, an estimated 629,000 participants (aged 20–79 years) in Switzerland suffer from diabetes, corresponding to a prevalence of 8.9%. These numbers are similar to those in Germany and Austria, but higher than in other northern European countries, such as Belgium, The Netherlands (5.3%), and France (6.7%).⁶ However, accurate prevalences of diabetes can only be derived from structured, population-based studies. From a methodologic perspective, our investigation does not fulfill all the criteria of a proper population-based study and the willingness to undergo voluntary blood glucose testing might favor the enrollment of the more health-conscious subjects. Nevertheless, participants consulting a pharmacist can be considered as a largely unselected population due to the large

Table 3 Distribution of glucose control by region and canton based on a total survey population of 3135

Region/canton	Inhabitants (×1000)	Number of participants	IFG n (% of participants)	Newly diagnosed diabetes n (% of participants)	Known diabetes n (% of participants)
SUI-GER	4688	1681	174 (10.4)	32 (1.9)	60 (3.6)
Aargau	600	143	8 (5.6)	5 (3.5)	4 (2.8)
Bern	974	403	36 (8.9)	8 (2.0)	12 (3.0)
Basel-Land	173	38	3 (7.9)	0 (0)	2 (5.3)
Basel-Stadt	188	300	45 (15.0)	6 (2.0)	9 (3.0)
Graubünden	192	203	11 (5.4)	1 (0.5)	6 (3.0)
Luzern	372	91	7 (7.7)	2 (2.2)	9 (9.9)
St Gallen	474	150	14 (9.3)	2 (1.3)	2 (1.3)
Solothurn	253	16	3 (18.7)	0 (0)	0 (0.0)
Zug	111	50	4 (8.0)	3 (6.0)	1 (2.0)
Zurich	1351	283	41 (14.5)	5 (1.8)	15 (5.3)
SUI-FR/IT	2482	1454	185 (12.7)	27 (1.9)	71 (4.9)
Fribourg	273	299	28 (9.4)	5 (1.7)	9 (3.0)
Geneva	453	425	73 (17.2)	7 (1.6)	34 (8.0)
Jura	70	99	5 (5.0)	2 (2.0)	1 (1.0)
Neuchatel	171	249	28 (11.2)	4 (1.6)	13 (5.2)
Schaffhausen	171	4	2 (50.0)	0 (0)	0 (0.0)
Tessin	335	267	43 (16.1)	8 (3.0)	9 (3.4)
Waadtland*	701	12	2 (16.7)	0 (0)	1 (8.3)
Wallis	308	103	6 (5.8)	1 (1.0)	4 (3.9)
Total	7776	3135	359 (11.5)	59 (1.9)	131 (4.1)

Note: *Participation was low due to another concomitant study.

Abbreviations: IFG, impaired fasting glucose; SUI-FR/IT, French/Italian-speaking part of Switzerland; SUI-GER, German speaking part of Switzerland.

age spectrum and the variety of reasons for a pharmacy visit. One population-based study was conducted in the French-speaking region of Switzerland (Lausanne), and reported an overall diabetes prevalence of 6.6% in participants aged 35–75 years, of which only 66.3% were known cases of diabetes.⁴ Even though the low number of study participants in the canton of Waadtland (Lausanne region) in our study does not allow for any conclusions, the overall prevalence of 6.8% in the SUI-FR/IT region (4.9% with known/1.9% with newly diagnosed diabetes) corresponds well to these published data, mostly driven by the comparatively high number of diabetic participants in the canton of Geneva (9.6% new and known diabetes combined). Interestingly, the overall prevalence for diabetes appears to be lower in the SUI-GER part of Switzerland, especially in the cantons of Bern, Basel-Stadt, and Graubünden, but there was considerable heterogeneity observed between cantons, which remains unexplained.

Diabetes and risk factor control

The recently published Swiss health survey shows self-reported diabetes control rates of 65.5% for the year 2007.³ In line with these findings, data from our survey suggest the presence of uncontrolled diabetes in about 45% of participants with known diabetes (29% with a diabetic profile/15.3% with impaired fasting glucose) based on a single random blood glucose test and where the majority of participants were treated with oral antidiabetic drugs alone. However, these data have to be interpreted with extreme caution, given that a single capillary blood glucose test is not a suitable tool to establish the level of blood glucose control in participants with diabetes, but rather a prescreening tool.⁷ Further, the total number of diabetic participants was low in our study, which also represents a major limitation for making conclusions on blood glucose control in diabetic participants in Switzerland.

In our study, established cardiometabolic risk factors, such as elevated body mass index, a family history of diabetes, hypertension, hypercholesterolemia, smoking and a low level of physical exercise appeared to be associated with impaired glucose metabolism, confirming well known previous observations in this Swiss population.^{8–10} Even though the prognostic relevance of treating diabetes and impaired fasting glucose with regards to microvascular and macrovascular complications are undisputed, there is a lack of prospective data supporting the cost-effectiveness of structured screening initiatives.^{11–13} However, screening allows for

early identification of individuals affected by diabetes or at risk of diabetes, and such initiatives, even when conducted at unconventional locations such as optometry practices, have been shown to be useful.¹⁴

Diabetes screening

Screening for diabetes in asymptomatic patients has been challenged recently¹⁵ for having no beneficial effect on overall health outcomes. To our knowledge, there are no randomized, controlled trial data and only one relevant case-control study, and neither showing a benefit when considering microvascular complications. However, there are data to support screening being effective in hypertensive persons when macrovascular benefits are considered. Therefore, targeted screening might be more effective than mass screening.

The most recent guidelines of the American Diabetes Association for screening and diagnosis of diabetes require a glycosylated hemoglobin $\geq 6.5\%$, a fasting plasma glucose ≥ 126 mg/dL or a 2-hour plasma glucose ≥ 200 mg/dL, or symptoms of hyperglycemia in patients with a random plasma glucose ≥ 200 mg/dL.¹⁶ Fasting is defined as no caloric intake for at least 8 hours. Just as there is less than 100% concordance between fasting plasma glucose and 2-hour plasma glucose tests, there is not full concordance between glycosylated hemoglobin and either glucose-based test. Analyses of National Health and Nutrition Examination Survey data indicate that, assuming universal screening of the undiagnosed, the glycosylated hemoglobin cut point $\geq 6.5\%$ identifies one-third fewer cases of undiagnosed diabetes than a fasting glucose cut point ≥ 126 mg/dL (7.0 mmol/L).¹⁶

In the clinical as well as in the research environment, the required fasting status is a challenging task. For clinicians and patients it is much simpler to obtain random glucose values irrespective of the fasting duration. In studies, especially epidemiologic ones, the fasting requirement influences the study design, complicates the field work, and increases the costs of the study. Moreover, and most important, it is not feasible to control reliably for self-reported fasting status. Therefore, random blood glucose values have been used as a type of prescreening measure to identify individuals in which a repeat testing under fasting conditions is necessary.^{7,17} For the results of the present study, this means that a number of patients (ie, those with indeterminate blood glucose) may be either normal or have impaired fasting glucose or diabetes. The conclusion is that the prevalence rates reported in our survey for new diabetes are a conservative estimate of the true prevalence.

Limitations

Despite the straightforward approach of testing patients for the presence for dysglycemia in a large number of pharmacies in Switzerland, a number of limitations have to be considered when assessing the results of this study. A confirmation of the results of random blood glucose monitoring in largely nonfasting subjects in the same subjects after 8 hours of fasting or by assessing glycosylated hemoglobin, as suggested by the recent American Diabetes Association recommendation, would have been useful, but was not possible for logistic reasons. We obtained no data on subjects who did not participate in the study, so we cannot rule out the possibility that males, for example, who comprised 27% of the study population, were not visiting pharmacies because of having to work. Finally, the population visiting pharmacies may not be totally representative of the overall population, or may have been affected by common cold, for example, which may introduce bias into blood glucose determination.

Conclusion

In our survey, a total of 59 participants were identified with newly diagnosed diabetes by 102 pharmacies. Given that there are about 1700 retail pharmacies in Switzerland, such an initiative may contribute to identification of a substantial number of participants with unknown diabetes. This would enable early treatment and prevention of diabetes and/or diabetes-related complications.

Disclosure

The present study was conducted as a collaboration between Sanofi Aventis Switzerland and the AMAVITA pharmacy chain. At the time of this survey, AR and MT were employees of Sanofi Aventis, Switzerland. PB has received honoraria for lectures and consulting fees from a number of companies producing antidiabetic drugs, including Sanofi Aventis, Bristol Myers Squibb, AstraZeneca, and Takeda. CAM and RF report no conflicts of interest with respect to the current manuscript. The study was supported by Sanofi-Aventis, Meyrin, Switzerland.

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