MSR108

IDENTIFYING DIABETES TYPES BY MODELLING DRUG CONSUMPTION AND PATIENT PROFILE DATA FROM PHARMACIES

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INTRODUCTION

Diabetes is a metabolic disorder resulting in chronic hyperglycemia due to defects in insulin secretion or insulin action or both. Most diabetes disorders are classified as type 1 or type 2, depending on their origin. Five percent of the French population receives pharmacological treatment for a diabetes disorder. Although some treatments cover all types of diabetes, patient care differs depending on the diabetes type. This study aimed to establish a statistical model to distinguish and predict types 1 or 2 diabetes from demographic and drug consumption data, in the absence of clinical data.

METHOD

We identified a cohort of patients diagnosed as diabetics in France, with a single ICD-10 diagnosis code of either E10 or E11 and at least one confirmation of the same diagnosis in the last 24 months of care, in THIN®—the GERS DATA medical database comprising records from 3,000 practitioners, including 2,000 GPs and 55 endocrinologists in France. We extracted data concerning ATC code A10 drugs. Patients who were only treated with SGLT2 inhibitors were excluded from the study.

In 2021, 73,498 patients fulfilled these criteria. We divided them into two groups: 51,449 patients on whom we based our work, and 22,049 patients who were stratified by diabetes type to validate the algorithm. Within those 2 groups in the THIN® database, we selected a logistic model and applied it to the SOG Health by GERS DATA pharmacy database, which includes patient's demographic and drug consumption data from 10,632 pharmacies.

FR

> 4,5 M patients / year
3,000 physicians
Since 1994

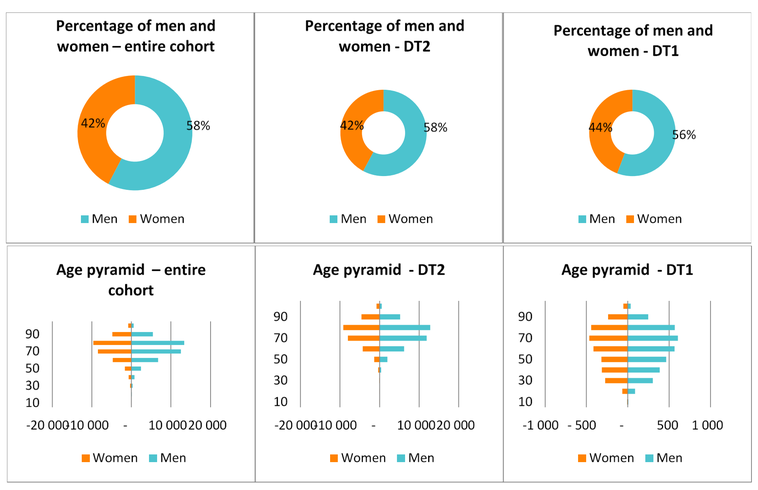
Specialty in FR	Network	Patients
GPs	2 000	> 3,200,000
Cardiologists	205	> 200,000
Gynecologists	165	> 300,000
Rheumatologists	150	> 200,000
Psychiatrists	140	> 40,000
Gastroenterologists	130	> 180,000
Neurologists	90	> 130,000
Pulmonologists	65	> 80,000
Endocrinologists	55	> 60,000
Pediatricians	55	> 70,000
Dermatologists	26	> 50,000

Source: THIN® database - October 2022

RESULTS

Most patients identified in the cohort were DT2 (92%). The average age was 67 and 42% were women (**Figure 1**).

Figure 1: Gender and age breakdown



We tested several models. The most significant variables were combined therapies (**Table 1**): rapid-acting insulin, mixed-insulin, long-acting insulin, metformin, other oral anti-diabetics (OADs), and age (≥57 and <57).

Table 1:
Test parameter and significance estimates

		Analysis of Maximum Likelihood Estimates			
Label	*DF*	*Estimate*	*Standard Error*	*Wald Chi-Square*	*Pr > ChiSq*	*Pr > CI*
	1	-2.5683	0.1708	226.0840	<.0001	<
OAD	1	6.1538	0.2409	652.7643	<.0001	<
OAD and long-acting insulin	1	3.7709	0.2122	315.8737	<.0001	<
OAD, long-acting insulin and metformin	1	4.4177	0.1827	584.4128	<.0001	<
OAD and mixed-insulin	1	2.5934	0.1889	188.5539	<.0001	<
OAD, mixed-insulin and metformin	1	3.3135	0.1782	345.6190	<.0001	<
OAD and rapid-acting insulin	1	2.4417	0.3526	47.9521	<.0001	<
OAD, rapid-acting insulin and metformin	1	3.4941	0.2853	149.9435	<.0001	<
OAD and metformin	1	6.6863	0.1940	1187.4566	<.0001	<
long-acting insulin	1	2.1981	0.2044	115.6351	<.0001	<
long-acting insulin and metformin	1	3.5756	0.2021	313.0042	<.0001	<
mixed-insulin	1	0.9248	0.1729	28.6033	<.0001	<
mixed-insulin and metformin	1	2.3173	0.1790	167.5653	<.0001	<
Rapid-acting insulin and metformin	1	2.9414	0.3155	86.9145	<.0001	<
Metformin	1	7.3455	0.2172	1143.8608	<.0001	<
≥57 years old	1	1.3403	0.0493	739.4994	<.0001	<

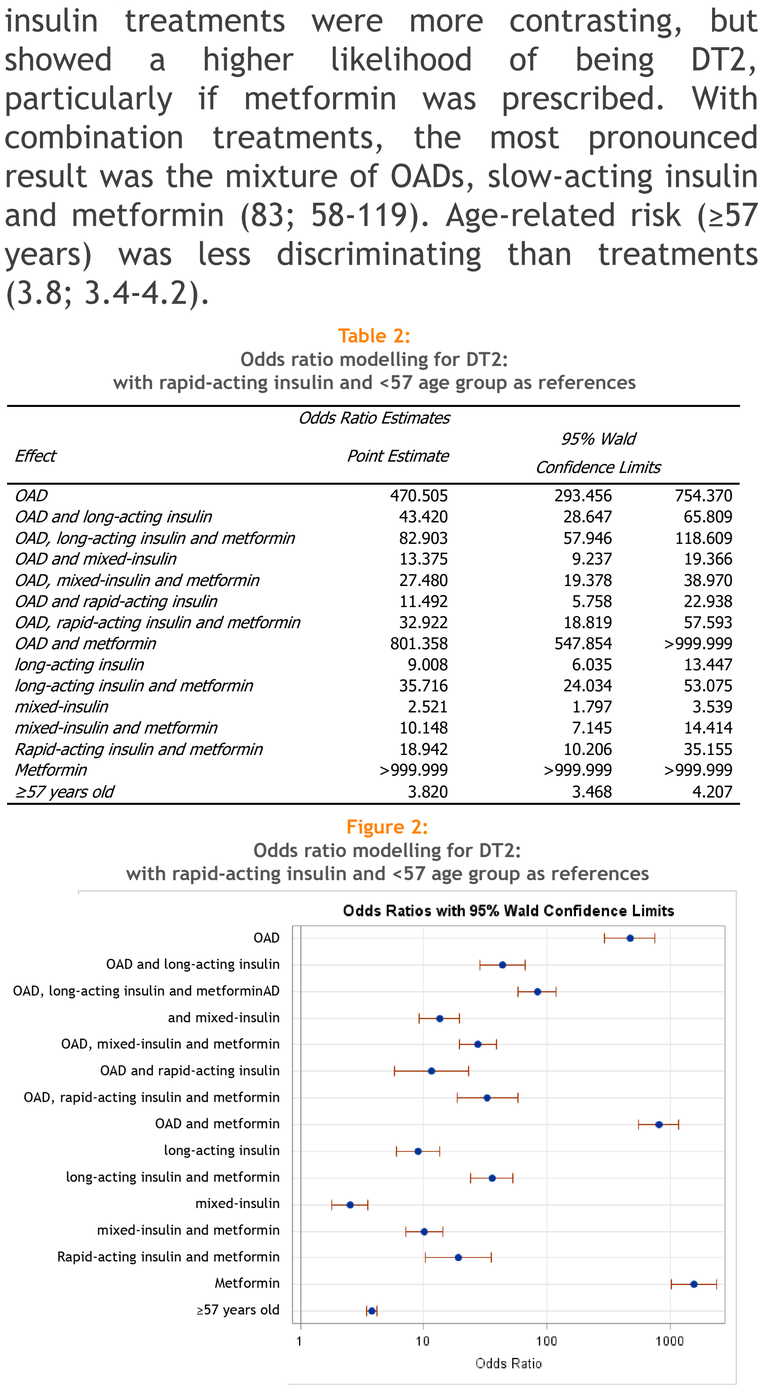
The data showed a clear divide between OAD and insulin (**Table 2 and Figure 2**). Compared with rapid-acting insulin, metformin increased the likelihood of being DT2, whether administered alone (OR >999; CI >999->999) or in combination with other OADs (801; 548->999).

Likewise, the other OADs increased the likelihood of being DT2 (470; 293-750). The more rapid-acting the insulin-only therapy is, the lower the likelihood of being DT2. The results for combined OAD and insulin treatments were more contrasting, but showed a higher likelihood of being DT2, particularly if metformin was prescribed. With combination treatments, the most pronounced result was the mixture of OADs, slow-acting insulin and metformin (83; 58-119). Age-related risk (≥57 years) was less discriminating than treatments (3.8; 3.4-4.2).

Table 2:
Odds ratio modelling for DT2:
with rapid-acting insulin and <57 age group as references

	Odds Ratio Estimates		
Effect	*Point Estimate*	*95% Wald Confidence Limits*	
OAD	470.505	293.456	754.370
OAD and long-acting insulin	43.420	28.647	65.809
OAD, long-acting insulin and metformin	82.903	57.946	118.609
OAD and mixed-insulin	13.375	9.237	19.366
OAD, mixed-insulin and metformin	27.480	19.378	38.970
OAD and rapid-acting insulin	11.492	5.758	22.938
OAD, rapid-acting insulin and metformin	32.922	18.819	57.593
OAD and metformin	801.358	547.854	>999.999
long-acting insulin	9.008	6.035	13.447
long-acting insulin and metformin	35.716	24.034	53.075
mixed-insulin	2.521	1.797	3.539
mixed-insulin and metformin	10.148	7.145	14.414
Rapid-acting insulin and metformin	18.942	10.206	35.155
Metformin	>999.999	>999.999	>999.999
≥57 years old	3.820	3.468	4.207

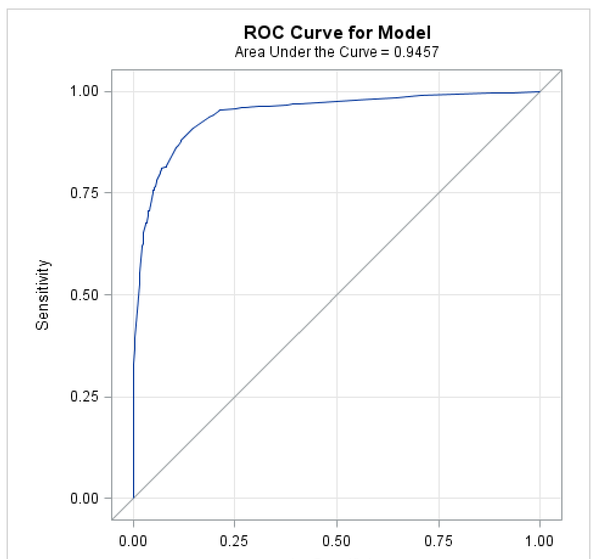
Figure 2:
Odds ratio modelling for DT2:
with rapid-acting insulin and <57 age group as references



This model was applied to the validation sample of 22,049 patients: 95% of DT2 patients were well classified (**Figure 3**) with a Sensitivity of 98%, a Specificity of 65%, a PPV of 97% and a NVP of 71%.

By changing the different parameters, this model can serve as a modular basis depending on the type of diabetes and the level of precision required. For example, for DT1 patients, we were able to obtain a Sensitivity of 67%, a Specificity of 97%, a PPV of 67% and a NPV of 97%.

Figure 3:
ROC curve for model



We applied this model to the SOG Health by GERS DATA pharmacy database which includes patients demographic and drug consumption data for over half the pharmacies in France.

We were then able to determine whether patients were DT1 or DT2 based on their age and consumption of ATC Class A10 drugs. It is now possible to build RWE studies including incidence, prevalence and therapeutic consumption of diabetic patients on this database.

CONCLUSION

This study shows that by combining a logistic regression model with a sensitivity and specificity analysis, diabetes types can be predicted, based on a patient's age and consumption of pharmaceutical drugs.
This type of model is useful to enrich and medicalise databases that lack primary care data, such as the SNDS (French health data system).

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