Identifying Ontarians with type 2 diabetes mellitus in administrative data: A comparison of two case definitions

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Supplementary Table 1. Description of ICES databases

Name	Description
DAD - Discharge Abstract Database	Administrative, clinical and demographic information on hospital discharges (including deaths, sign-outs and transfers).[1]
NACRS - National Ambulatory Care Reporting System	Contains information on emergency department (ED) visits, outpatient and community-based clinics, and same day surgeries.[2]
ODB - Ontario Drug Benefit	Provides a record of all influenza vaccinations distributed in an Ontario pharmacy setting. Also includes public coverage of medications for: all persons aged 65+ years; and select groups such as: people living in long-term care home, receiving benefits from Ontario Works or Ontario Disability Support Program, enrolled in the Trillium Drug Program, and individuals <25 years not covered on private insurance (OHIP+).[3]
ODD - Ontario Diabetes Dataset	ICES-derived cohort that defines Ontarians with diabetes based on their administrative data holdings using a validated algorithm.[4]
OHIP - Ontario Health Insurance Plan Claims Database	Physician billing claims records of all transactions paid for by OHIP, including physician billing claims for administration of influenza vaccinations.

[1] Canadian Institute for Health Information. Discharge Abstract Database metadata (DAD) 2020 [cited 2020 July 21]. Available from: https://www.cihi.ca/en/discharge-abstract-database-metadata-dad

[2] Canadian Institute for Health Information. National Ambulatory Care Reporting System metadata (NACRS) 2020 [cited 2020 July 21]. Available from: https://www.cihi.ca/en/national-ambulatory-care-reporting-system-metadata-nacrs.

[3] Government of Ontario. Get coverage for prescription drugs 2020 [cited 2020 July 21]. Available from: https://www.ontario.ca/page/get-coverage-prescription-drugs.

[4] Hux JE, Ivis F, Flintoft V, Bica A. Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. Diabetes care. 2002;25(3):512-6. Epub 2002/03/05. doi: 10.2337/diacare.25.3.512. PubMed PMID: 11874939.

Name	Description
OLIS – Ontario Laboratories Information System	Contains laboratory test results from specimens submitted as part of routine clinical care, outbreak investigations, or research to 11 Public Health Ontario laboratories and nine academic hospital laboratories across Ontario.
RPDB - Registered Persons Database	Demographic information on all individuals with an Ontario Health Card (OHIP card)

Supplementary Table 2. Comorbidity diagnosis codes

Category	Codes	Description
Type 2 Diabetes Mellitus	ICD-10-CA E11	Type 2 diabetes mellitus *Includes:* Diabetes (mellitus)(nonobese)(obese): • adult-onset • due to insulin secretory defect • insulin resistant • maturity-onset • non insulin dependent diabetes mellitus of young [NIDDMY]
Diabetes Mellitus	ICD-10-CA E13	Other specified diabetes mellitus *Includes:* Diabetes mellitus due to genetic defects (in) (of): • beta-cell function • insulin action Maturity onset diabetes of the young [MODY] Steroid induced diabetes mellitus
	ICD-10-CA E14	Unspecified diabetes mellitus *Includes:* Diabetes mellitus NOS
	OHIP 248	Diabetes Mellitus with Ocular Complications
	OHIP 250	Diabetes Mellitus (Including Complications)
Type 1 Diabetes Mellitus	ICD-10-CA E10	Type 1 diabetes mellitus *Includes:* Diabetes (mellitus): • autoimmune • brittle • idiopathic

Category	Codes	Description
		• insulin dependent • juvenile onset
	ICD-9-CM 250.01	Diabetes mellitus without mention of complication, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.03	Diabetes mellitus without mention of complication, type I [juvenile type], uncontrolled
	ICD-9-CM 250.11	Diabetes with ketoacidosis, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.13	Diabetes with ketoacidosis, type I [juvenile type], uncontrolled
	ICD-9-CM 250.21	Diabetes with hyperosmolarity, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.23	Diabetes with hyperosmolarity, type I [juvenile type], uncontrolled
	ICD-9-CM 250.31	Diabetes with other coma, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.33	Diabetes with other coma, type I [juvenile type], uncontrolled
	ICD-9-CM 250.41	Diabetes with renal manifestations, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.43	Diabetes with renal manifestations, type I [juvenile type], uncontrolled
	ICD-9-CM 250.51	Diabetes with ophthalmic manifestations, type I [juvenile type], not stated as uncontrolled

Category	Codes	Description
	ICD-9-CM 250.53	Diabetes with ophthalmic manifestations, type I [juvenile type], uncontrolled
	ICD-9-CM 250.61	Diabetes with neurological manifestations, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.63	Diabetes with neurological manifestations, type I [juvenile type], uncontrolled
	ICD-9-CM 250.71	Diabetes with peripheral circulatory disorders, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.73	Diabetes with peripheral circulatory disorders, type I [juvenile type], uncontrolled
	ICD-9-CM 250.81	Diabetes with other specified manifestations, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.83	Diabetes with other specified manifestations, type I [juvenile type], uncontrolled
	ICD-9-CM 250.91	Diabetes with unspecified complication, type I [juvenile type], not stated as uncontrolled
	ICD-9-CM 250.93	Diabetes with unspecified complication, type I [juvenile type], uncontrolled
Microalbuminuria	LOINC: 14957-5 1754-1 XON12400-8 14959-1 300000-4	24h urine collection: 30-300 mg/24h Short-time urine collection: 20-200 mcg/min Spot urine albumin sample: 30-300 mg/L Spot urine albumin/creatinine ratio women: 30-400 mcg/mg Spot urine albumin/creatinine ratio men: 30-300 mcg/mg

Category	Codes	Description
	32294-1 2889-4 21482-5 34366-5	
	ICD-10-CA E11.20	**Type 2 diabetes mellitus with incipient diabetic nephropathy (N08.3-*)** *Includes:* Type 2 diabetes mellitus with: • conditions classified in N18.1 - N18.2 (N08.31* - N08.32*) • glomerular basement-membrane thickening • glomerular mesangial expansion • incipient nephropathy (early) (mild) (reversible) • microalbuminuria (constant) (persistent)
	ICD-10-CA E13.20	**Other specified diabetes mellitus with incipient diabetic nephropathy (N08.3-*)** *Includes:* Other specified diabetes mellitus with: • conditions classified in N18.1 - N18.2 (N08.31* - N08.32*) • glomerular basement-membrane thickening • glomerular mesangial expansion • incipient nephropathy (early) (mild) (reversible) • microalbuminuria (constant) (persistent)
	ICD-10-CA E14.20	**Unspecified diabetes mellitus with incipient diabetic nephropathy (N08.3-*)** *Includes:* Unspecified diabetes mellitus with:

Category	Codes	Description
		• conditions classified in N18.1 - N18.2 (N08.31* - N08.32*)
		• glomerular basement-membrane thickening
		• glomerular mesangial expansion
		• incipient nephropathy (early) (mild) (reversible)
		• microalbuminuria (constant) (persistent)
(Macro)albuminuria	LOINC: 14957-5 1754-1 XON12400-8 14959-1 300000-4 32294-1 2889-4 21482-5 34366-5	24h urine collection: >300 mg/24h Short-time urine collection: >200 mcg/min Spot urine albumin sample: >300 mg/L Spot urine albumin/creatinine ratio women: >400 mcg/mg Spot urine albumin/creatinine ratio men: >300 mcg/mg
	ICD-10-CA R80	Isolated proteinuria *Includes:* Albuminuria NOS Bence Jones proteinuria Proteinuria NOS
	ICD-10-CA E11.23	Type 2 diabetes mellitus with established or advanced kidney disease (N08.3-*) Includes: Type 2 diabetes mellitus with: • chronic kidney (renal):

Category	Codes	Description
		• failure
		• impairment
		• conditions classified in N18.3 - N18.5 (N08.33* - N08.35*)
		• end-stage kidney disease (ESKD)
		• established diabetic nephropathy
		• glomerulosclerosis (diffuse) (intracapillary) (nodular)
		• Kimmelstiel-Wilson (disease) (lesion)
		• macroalbuminuria
		• nephropathy (advanced) (progressive) (NOS)
		• nephrosis
		• nephrotic syndrome
		• proteinuria (constant) (persistent)
	ICD-10-CA E13.23	Other specified diabetes mellitus with established or advanced kidney disease (N08.3-*)
		Includes: Other specified diabetes mellitus with:
		• chronic kidney (renal):
		• failure
		• impairment
		• conditions classified in N18.3 - N18.5 (N08.33* - N08.35*)
		• end-stage kidney disease (ESKD)
		• established diabetic nephropathy
		• glomerulosclerosis (diffuse) (intracapillary) (nodular)
		• Kimmelstiel-Wilson (disease) (lesion)

Category	Codes	Description
		• macroalbuminuria • nephropathy (advanced) (progressive) (NOS) • nephrosis • nephrotic syndrome • proteinuria (constant) (persistent)
	ICD-10-CA E14.23	Unspecified diabetes mellitus with established or advanced kidney disease (N08.3-*) Includes: Unspecified diabetes mellitus with: • chronic kidney (renal): • failure • impairment • conditions classified in N18.3 - N18.5 (N08.33* - N08.35*) • end-stage kidney disease (ESKD) • established diabetic nephropathy • glomerulosclerosis (diffuse) (intracapillary) (nodular) • Kimmelstiel-Wilson (disease) (lesion) • macroalbuminuria • nephropathy (advanced) (progressive) (NOS) • nephrosis • nephrotic syndrome • proteinuria (constant) (persistent)
CKD Stage 1	ICD-10-CA N08.31	Glomerular disorders in diabetes mellitus, chronic kidney disease, stage 1

Category	Codes	Description
		Includes: Kidney damage with normal or increased GFR ([ge]90 mL/min)
	ICD-10-CA N18.1	Chronic kidney disease, stage 1 *Includes:* Kidney damage with normal or increased GFR ([ge]90 mL/min)
CKD Stage 2	ICD-10-CA N08.32	Glomerular disorders in diabetes mellitus, chronic kidney disease, stage 2 *Includes:* Kidney damage with mild decreased GFR (60-89 mL/min)
	ICD-10-CA N18.2	Chronic kidney disease, stage 2 *Includes:* Kidney damage with mild decreased GFR (60-89 mL/min)
CKD Stage 3	ICD-10-CA N08.33	Glomerular disorders in diabetes mellitus, chronic kidney disease, stage 3 *Includes:* Kidney damage with moderately decreased GFR (30-59 mL/min)
	ICD-10-CA N18.3	Chronic kidney disease, stage 3 *Includes:* Kidney damage with moderately decreased GFR (30-59 mL/min)
CKD Stage 4	ICD-10-CA N08.34	Glomerular disorders in diabetes mellitus, chronic kidney disease, stage 4 *Includes:* Kidney damage with severely decreased GFR (15-29 mL/min)
	ICD-10-CA N18.4	Chronic kidney disease, stage 4

Category	Codes	Description
		Includes: Kidney damage with severely decreased GFR (15-29 mL/min)
ESRD	ICD-10-CA N08.35	Glomerular disorders in diabetes mellitus, chronic kidney disease, stage 5 *Includes:* End-stage kidney disease (ESKD)
	ICD-10-CA N18.5	Chronic kidney disease, stage 5 *Includes:* End stage kidney disease: • NOS • in allograft failure • on dialysis • without dialysis or transplant Renal retinitis† (H32.8*) Uraemic: • apoplexia† (I68.8*) • dementia† (F02.8*) • neuropathy† (G63.8*) • paralysis† (G99.8*) • pericarditis† (I32.8*)
	ICD-10-CA N19	**Unspecified kidney failure** ***Includes:*** Renal insufficiency NOS Uraemia NOS
MI	ICD-10-CA I21	Acute myocardial infarction

Category	Codes	Description
		Includes: myocardial infarction specified as acute or with a stated duration of 4 weeks (28 days) or less from onset
	OHIP 410	Myocardial Infarction Acute, Coronary Thrombosis
Chronic Ischemic Heart Disease	ICD-10-CA I25	Chronic ischaemic heart disease
	OHIP 412	Old myocardial infarction, chronic coronary artery disease of arteriosclerotic heart disease, without symptoms
Angina	ICD-10-CA I20 which includes all subcodes (e.g. I20.0, I20.9).	Unstable angina
	OHIP 413	Acute coronary insufficiency, angina pectoris, acute ischaemic heart disease
CHF	ICD-10-CA I50	Heart failure
	OHIP 428	Congestive Heart Failure
	OHIP Q050A	Heart Failure Management Incentive (Annual)
Dyslipidemia	ICD-10-CA E78	Disorders of lipoprotein metabolism and other lipidaemias
	OHIP 272	Hypercholesterolemia
Hypertension	ICD-10-CA I10	Essential (primary) hypertension
	ICD-10-CA I11	Hypertensive heart disease
	ICD-10-CA I12	Hypertensive renal disease
	ICD-10-CA I13	Hypertensive heart and renal disease
	ICD-10-CA I15	Secondary hypertension
	OHIP 401	Hypertension, Essential

Category	Codes	Description
	OHIP 402	Hypertensive heart disease
	OHIP 403	Hypertensive renal disease
Stroke	ICD-10-CA I60	Subarachnoid haemorrhage
	ICD-10-CA I61	Intracerebral haemorrhage
	ICD-10-CA I63(excluding I63.6)	Cerebral infarction
	ICD-10-CA I64	Stroke, not specified as haemorrhage or infarction
	ICD-10- H34.1	Central retinal artery occlusion
	OHIP 432	Intracranial Haemorrhage
	OHIP 436	Acute cerebrovascular accident, C.V.A., stroke
TIA	ICD-10-CA G45 (excluding G45.4)	Transient cerebral ischaemic attacks and related syndromes
	ICD-10-CA H34.0	Transient retinal artery occlusion
	OHIP 435	Transient cerebral ischaemia
Venous thromboembolism	ICD-10-CA I26	Pulmonary embolism
	ICD-10-CA I80	Phlebitis and thrombophlebitis *Includes:* endophlebitis inflammation, vein periphlebitis suppurative phlebitis

Category	Codes	Description
	ICD-10-CA I81	Portal vein thrombosis
	ICD-10-CA I82	Other venous embolism and thrombosis
	OHIP 415	Pulmonary Embolism, Infarction
	OHIP 451	Phlebitis, thrombophlebitis
	OHIP 452	Portal vein thrombosis
PVD	ICD-10-CA E11.50	Type 2 diabetes mellitus with peripheral angiopathy (I79.2*) *Includes:* Type 2 diabetes mellitus with: • intermittent claudication • peripheral vascular disease, unspecified (PVD) • spasm of artery
	ICD-10-CA E11.51	Type 2 diabetes mellitus with peripheral angiopathy with gangrene (I79.2*)
	ICD-10-CA E13.50	Other specified diabetes mellitus with peripheral angiopathy (I79.2*) *Includes:* Other specified diabetes mellitus with: • intermittent claudication • peripheral vascular disease, unspecified (PVD) • spasm of artery
	ICD-10-CA E13.51	Other specified diabetes mellitus with peripheral angiopathy with gangrene (I79.2*)
	ICD-10-CA E14.50	Unspecified diabetes mellitus with peripheral angiopathy (I79.2*) *Includes:* Unspecified diabetes mellitus with:

Category	Codes	Description
		• intermittent claudication • peripheral vascular disease, unspecified (PVD) • spasm of artery
	ICD-10-CA E14.51	Unspecified diabetes mellitus with peripheral angiopathy with gangrene (I79.2*)
	ICD-10-CA I70.2	Atherosclerosis of arteries of extremities *Includes:* Atherosclerosis of (autologous) (bypass) (nonautologous) grafts of arteries of extremities Mönckeberg's (medial) sclerosis
	ICD-10-CA I73.9	Peripheral vascular disease, unspecified Includes: Intermittent claudication Spasm of artery
	ICD-10-CA I74.2	Embolism and thrombosis of arteries of upper extremities
	ICD-10-CA I74.3	Embolism and thrombosis of arteries of lower extremities
	ICD-10-CA I74.4	Embolism and thrombosis of arteries of extremities, unspecified Includes: Peripheral arterial embolism
	ICD-10-CA I79.2	Peripheral angiopathy in diseases classified elsewhere *Includes:* Diabetic peripheral angiopathy (E10-E14† with common fourth character .5)
	OHIP 443	Raynaud's disease, Buerger's disease, peripheral vascular disease, intermittent claudication

Category	Codes	Description
Obesity	ICD-10-CA E66	Obesity
	OHIP 278	Obesity
Lower Extremity Amputation	OHIP R520	Amputation - Metatarsal/phalanx disarticulation
	OHIP E585	Amputation - Metatarsal/phalanx disarticulation -each additional
	OHIP R621	Amputation - Ray (single)
	OHIP R623	Amputation - Symes
	OHIP R622	Amputation - Transmetatarsal/transtarsal
	OHIP R619	Amputation - Terminal Symes
Autonomic neuropathy	ICD-10-CA E11.42	Type 2 diabetes mellitus with autonomic neuropathy (G99.0*) *Includes:* Type 2 Diabetes mellitus with autonomic mononeuropathy/polyneuropathy: • abnormal sweating (gustatory) • anorectal dysfunction • diarrhea (functional) • erectile failure (impotence) • gastroparesis • hypotonic bladder • neuropathic edema • oesophageal dysfunction • postural hypotension
	ICD-10-CA E13.42	Other specified diabetes mellitus with autonomic neuropathy (G99.0*)

Category	Codes	Description
		Includes: Other specified diabetes mellitus with autonomic mononeuropathy/polyneuropathy: • abnormal sweating (gustatory) • anorectal dysfunction • diarrhea (functional) • erectile failure (impotence) • gastroparesis • hypotonic bladder • neuropathic edema • oesophageal dysfunction • postural hypotension
	ICD-10-CA E14.42	Unspecified diabetes mellitus with autonomic neuropathy (G99.0*) *Includes:* Unspecified diabetes mellitus with autonomic mononeuropathy/polyneuropathy: • abnormal sweating (gustatory) • anorectal dysfunction • diarrhea (functional) • erectile failure (impotence) • gastroparesis • hypotonic bladder • neuropathic edema • oesophageal dysfunction

Category	Codes	Description
		• postural hypotension
Retinopathy	ICD-10-CA E11.3	Type 2 diabetes mellitus with ophthalmic complications
	ICD-10-CA E13.3	Other specified diabetes mellitus with ophthalmic complications
	ICD-10-CA E14.3	Unspecified diabetes mellitus with ophthalmic complications
	ICD-10-CA H36.0	Diabetic retinopathy
Depression	ICD-10-CA F32	Depressive episode
	ICD-10-CA F33	Recurrent depressive disorder
	ICD-10-CA R45.2	Unhappiness *Includes:* Depression, not yet clinically diagnosed Feeling depressed Sadness Worries NOS
	OHIP 311	Depressive or Other Non-psychotic Disorder, Not Classified Elsewhere
Cirrhosis	K74	Fibrosis and cirrhosis of liver *Excludes:* alcoholic fibrosis of liver (K70.2) cardiac sclerosis of liver (K76.1) cirrhosis (of liver): • alcoholic (K70.3)

Category	Codes	Description
		• congenital (P78.80) with toxic liver disease (K71.7)
	OHIP 571	Alcoholic cirrhosis, biliary cirrhosis, cirrhosis of the liver

Supplementary Table 3: Cohort creation

	Specific	Sensitive
Inclusion Criteria		
ODD with HbA1c	N=938,952	N=1,265,329
Exclusion Criteria		
T1DM	145,872 (15.5%)	150,461 (11.9%)
Age <15 at ODD case detection	1,714 (0.2%)	1,978 (0.2%)
Age <30 at index date	4,360 (0.5%)	10,809 (0.9%)
OHIP ineligible at index or any of previous 4 quarters	3,765 (0.4%)	8,254 (0.7%)
Died before index	13 (0.0%)	15 (0.0%)
Included in cohort	783,228 (83.4%)	1,093,812 (86.4%)

ODD, Ontario Diabetes Database; OHIP, Ontario Health Insurance Plan; T1DM, type 1 diabetes

Supplementary Table 4. Prevalence of comorbidities

	Specific	Sensitive
Patient count, n	783,228	1,093,812
Autonomic neuropathy (n,%)	2,798 (0.4%)	2,965 (0.3%)
Congestive heart failure (n,%)	84,962 (10.8%)	114,590 (10.5%)
Chronic ischemic heart disease (n,%)	222,435 (28.4%)	299,469 (27.4%)
Cirrhosis (n,%)	14,279 (1.8%)	19,245 (1.8%)
Depression (n,%)	117,344 (15.0%)	170,599 (15.6%)
Dyslipidemia (n,%)	430,592 (55.0%)	596,048 (54.5%)
End stage renal disease (n,%)	11,972 (1.5%)	15,598 (1.4%)
Hypertension (n,%)	624,899 (79.8%)	845,747 (77.3%)
Lower extremity amputation (n,%)	1,505 (0.2%)	1,697 (0.2%)
Macroalbuminuria (n,%)	54,813 (7.0%)	62,039 (5.7%)
Myocardial infarction (n,%)	65,804 (8.4%)	90,555 (8.3%)
Microalbuminuria (n,%)	175,381 (22.4%)	317,430 (29.0%)
Obesity (n,%)	166,449 (21.3%)	232,060 (21.2%)
Peripheral vascular disease (n,%)	50,744 (6.5%)	66,780 (6.1%)
Retinopathy (n,%)	28,631 (3.7%)	30,413 (2.8%)
Stroke (n,%)	67,677 (8.6%)	92,956 (8.5%)
Transient ischemic attack (n,%)	45,464 (5.8%)	62,391 (5.7%)
Unstable angina (n,%)	169,053 (21.6%)	228,832 (20.9%)
Venous thromboembolism (n,%)	54,862 (7.0%)	77,118 (7.1%)