



Open-Source Diabetes Classifier on DARTER

Agenda

- Background & original implementation
- Validation & comparisons to RUKS
- Current implementation and limitations
- How to use it


Background: V1.0

- Spin-off from my PhD
- Only LPR2 and ICD-10 codes
- Medication data 1997 onward (GDM censoring)
- Calendar year limitation: 1997 - 2018

Clinical Epidemiology


Dovepress

open access to scientific and medical research

 Open Access Full Text Article

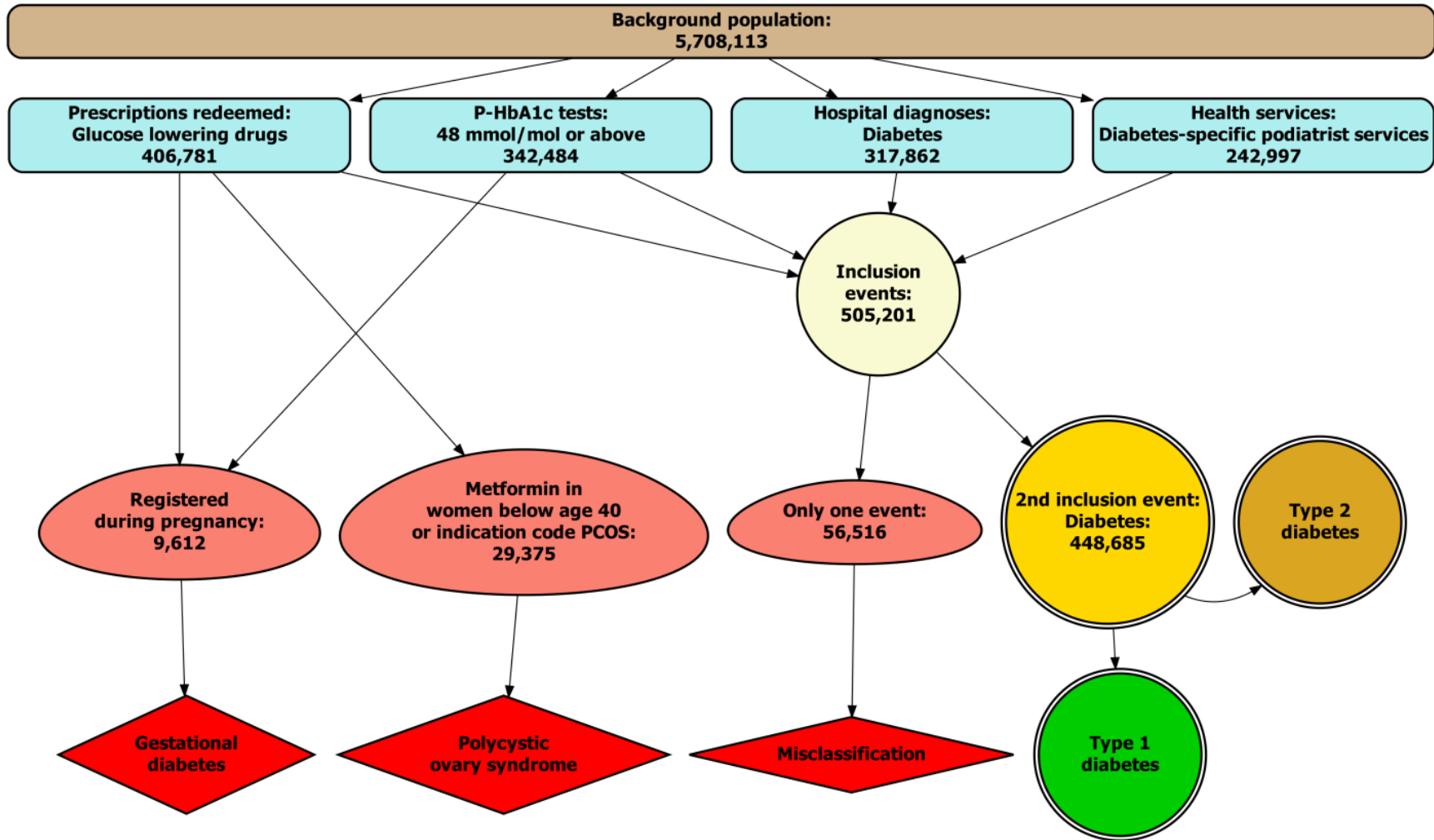
ORIGINAL RESEARCH

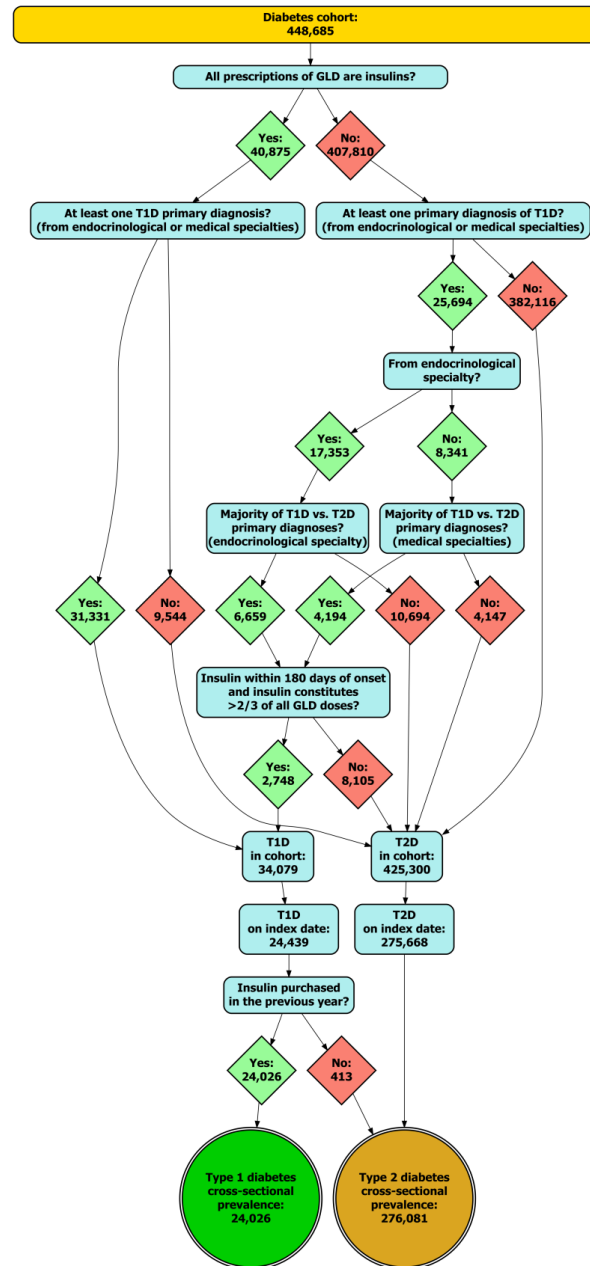
Validation of Register-Based Diabetes Classifiers in Danish Data

Anders Aasted Isaksen ^{1,2}, Anelli Sandbæk^{1,2}, Lasse Bjerg^{1,2}

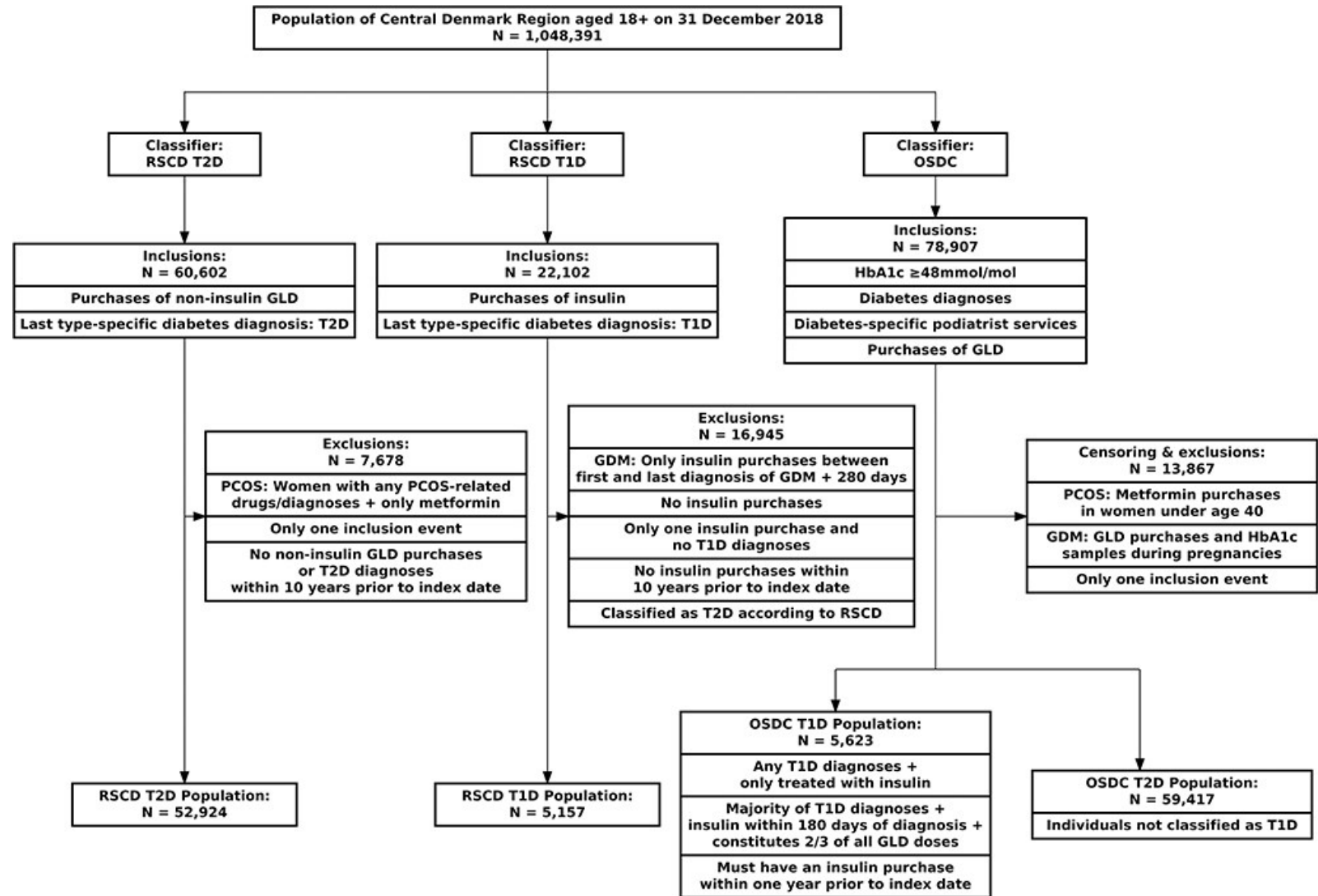
¹Department of Public Health, Aarhus University, Aarhus, Denmark; ²Steno Diabetes Center Aarhus, Aarhus University Hospital, Aarhus N, Denmark

Correspondence: Anders Aasted Isaksen, Institut for Folkesundhed, Aarhus Universitet, Bartholins Allé 2, Aarhus, 8000, Denmark, Email aai@ph.au.dk





Comparisons to RUKS (CDR)



Comparisons to RUKS

- T2D: ~4% higher sensitivity
 - Inclusions on HbA1c & OGTT
- T1D: ~ 7% higher sensitivity
 - Better algorithm (vs. RUKS)
- Both are fine (cross-sectional)

T1D				
OSDC	Survey: +T1D	Survey: -T1D	Total N	
OSDC: +T1D	317	19	336	PPV: 0.943 (0.913, 0.966)
OSDC: -T1D	93	28,962	29,055	NPV: 0.997 (0.996, 0.997)
Total N	410	28,981	29,391	
	Sensitivity: 0.773 (0.730, 0.813)	Specificity: 0.999 (0.999, 1.000)		
RSCD				
RSCD: +T1D	287	17	304	PPV: 0.944 (0.912, 0.967)
RSCD: -T1D	123	28,964	29,087	NPV: 0.996 (0.995, 0.996)
Total N	410	28,981	29,391	
	Sensitivity: 0.700 (0.653, 0.744)	Specificity: 0.999 (0.999, 1.000)		
T2D				
OSDC	Survey: +T2D	Survey: -T2D	Total N	
OSDC: +T2D	2098	299	2397	PPV: 0.875 (0.861, 0.888)
OSDC: -T2D	125	26,869	26,994	NPV: 0.995 (0.994, 0.996)
Total N	2223	27,168	29,391	
	Sensitivity: 0.944 (0.933, 0.953)	Specificity: 0.989 (0.988, 0.990)		
RSCD				
RSCD: +T2D	2011	229	2240	PPV: 0.898 (0.884, 0.910)
RSCD: -T2D	212	26,939	27,151	NPV: 0.992 (0.991, 0.993)
Total N	2223	27,168	29,391	
	Sensitivity: 0.905 (0.892, 0.917)	Specificity: 0.992 (0.990, 0.993)		

Notes: "-T1D" designates individuals with type 2 diabetes or no diabetes according to the source (classifier or survey), and "-T2D" designates individuals with type 1 diabetes or no diabetes.

Abbreviations: T1D, type 1 diabetes; T2D, type 2 diabetes; OSDC, Open-Source Diabetes Classifier; RSCD, Register for Selected Chronic Diseases; PPV, positive predictive value; NPV, negative predictive value.

Current DARTER implementation

- Supports LPR3 and ICD-8 diagnosis codes for inclusion & diabetes type
- No longer inclusion on semaglutid, dapagliflozin or empagliflozin.
- No longer requires insulin-purchase in previous year for T1D

Data source coverage

- Hospital diagnoses:
 - ICD-8: 1977 – 1993
 - ICD-10: 1994 – (LPR3 2019 -)
- Podiatrist services: 1990 -
- Medication: 1995 -
- HbA1c: 2008/**2011**/2015 -

Issues & limitations

- Diabetes onset prior to medication data is unlikely to be accurately captured by other sources.
- Diabetes onset is considered valid in cases with onset one year after availability of medication data or later.
- Onset of T1D may to some extent be captured by hospital diagnoses. If necessary for a given study design, diabetes duration in T1D cases onset prior to medication data can be used, but is not generally recommended.

Issues & limitations

- Medication data 1995-1996
 - Currently ignored
 - GDM censoring: Obstetric NPR codes 1997+
 - Medical Birth Register
 - A future option to enable GDM censoring and unlock medication inclusion events from 1995+

OSDC in practice on DARTER

- Currently:
 - "E:/workdata/708421/workspaces/diabetes_register_pop/dm_population_1977_2022.rds"
 - T1D: 47.947
 - T2D: 639.181

PNR	diabetes_type	do_dm	sex	date_of_birth	age_at_onset
01	2	2005-01-02	M	1994-12-12	68
02	2	1999-03-05	F	1921-05-05	77
03	1	1984-11-13	F	1945-09-21	39

- **How to use:**
 - Filter/merge to background/co-inclusion population by PNR, e.g.:
 - all PNR numbers in bef year 2012 to 2018 (sas/parquet)
 - individuals with incident CVD in a specific time-frame
 - Cross-sectional design, e.g. Jan 1 2020:
 - Filter/merge to bef year 2019 (alive and residing in Denmark)
 - Filter to do_dm < "2020-01-01" (prevalent diabetes)

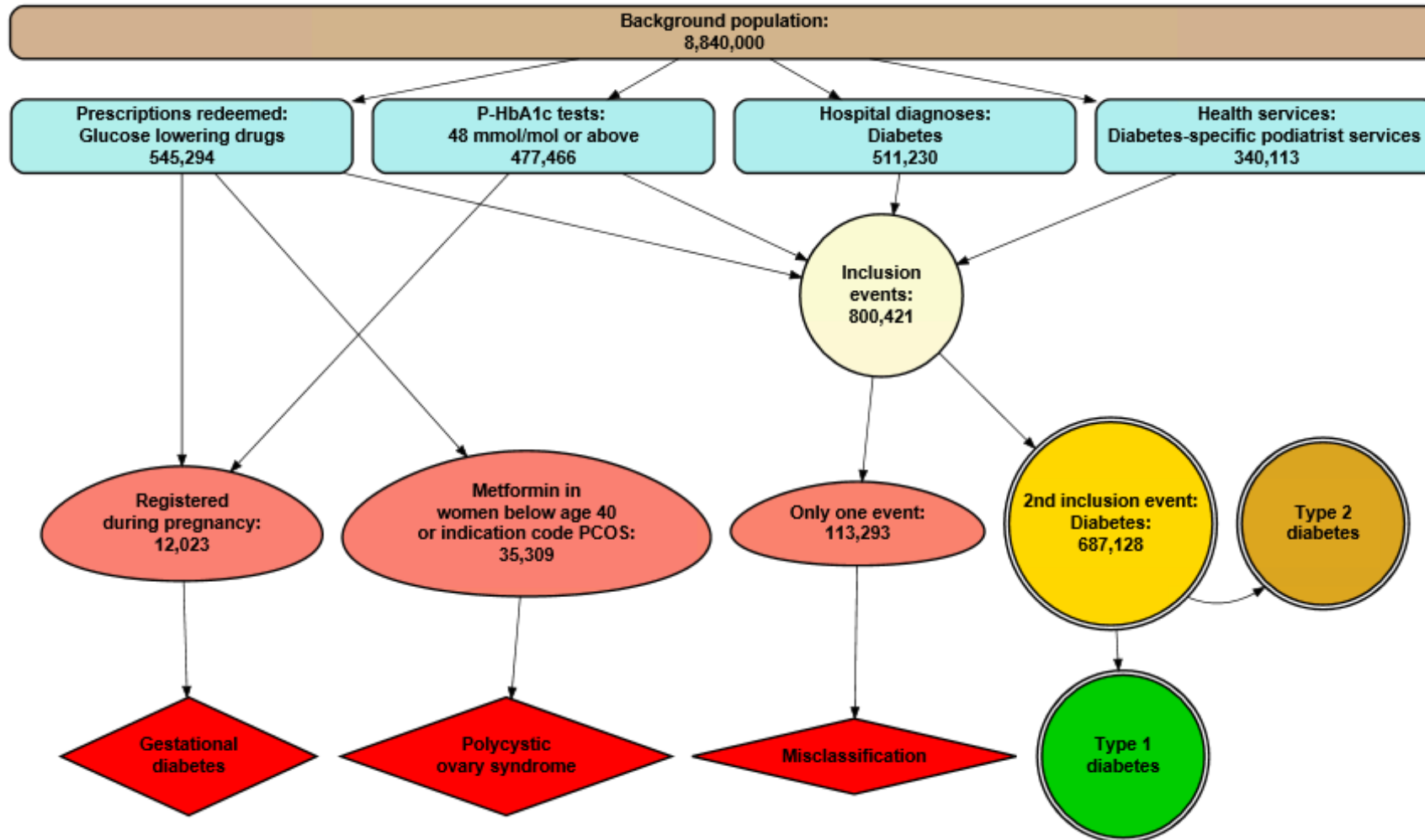
Remember limitations

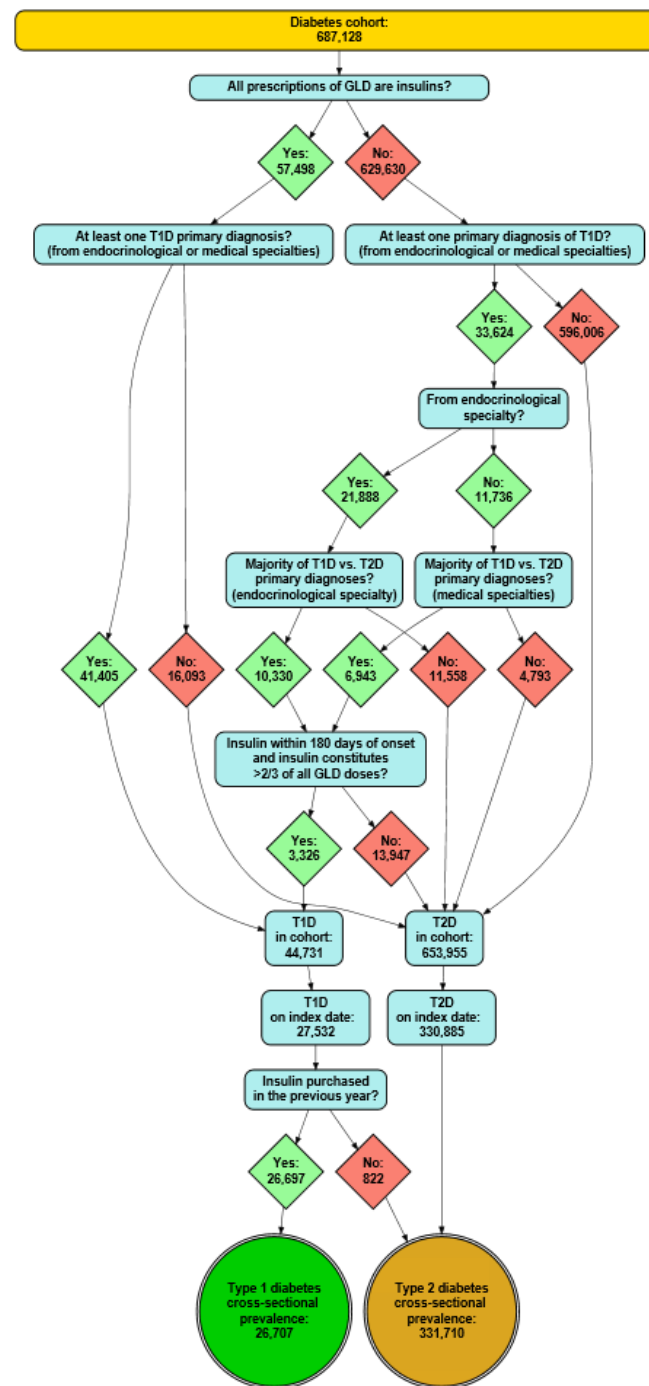
- Currently, incident cases from 1998 onward are considered valid.
- Date of onset/diabetes duration/age at onset:
 - If using this variable, exclude individuals with onset prior to 1998 (unless absolutely necessary)
 - Or make variable categorical
 - T1D: More leeway for using cases with onset prior to 1998

Future plans

- R package for ease of use.
- Use Medical Birth Register to squeeze in two extra years of valid inclusions
- Validate updated algorithm on HICD2023

Thank you!





Why omit some inclusion drugs?

- Semaglutid (Wegowy/Ozempic):
 - Demand/reimbursement/shortages may lead to Ozempic prescribed for non-DM weight loss, heart/kidney failure
- Dapa/emplagliflozin:
 - Entered guidelines for CKD & HF in 2021

INCREASED INCIDENCE OF TYPE 2 DIABETES?

- OSDC V1.0 in Central Denmark Region:
 - T2D incidence rate per 1000 person-years
 - 2019: 3.31 (3,293)
 - 2022: 8.71 (8,861)
 - $(8.861 - 3.547 = 5.314: 5.23 / 1000 \text{ PY})$

GLUCOSE-LOWERING DRUGS IN NON-DIABETES?

- Incident cases with only GLD purchases:
 - 2019: 145 (4.4%)
 - 2022: 3,791 (42.8%)
- Proportion of these included only due to purchases of (non-Wegowy) semaglutid, dapagliflozin or empagliflozin:
 - 2019: 87 (40%)
 - 2022: 3,547 (93.5%)

Issues for discussion

- Implementation of ICD-8 hospital diagnoses
 - Mainly for T1D inclusion/onset pre-1994?
 - Inclusion: exactly like ICD-10
 - Classify T1D from T2D only in absence of ICD-10 codes
 - T1D: >2 ICD-8 codes, majority of insulin-dependent codes: 249xx vs. 250xx: adds 3,200 T1D

Issues for discussion

- Reclassification of T1D for cross-sectional populations
 - Based on insulin-purchase in previous year
 - Reclassifies 1.7% of T1D -> T2D
 - ~ 75% of these self-report T1D in HICD-2019

Minor changes for discussion

- Medication inclusions:
 - VNR instead of drug name to filter out Saxenda/Wegovy in DARTER
- Hospital diagnoses for DM type-specification:
 - Removed need for PATTYPE (excluded ER)