

Supporting Info

Table S1. Description of Nonalcoholic Fatty Liver Disease (NAFLD) Exclusions

The following International Classification of Diseases ICD-9 and ICD-10 diagnostic codes and medications were used to exclude patients from the study population. Patients were excluded if they had ≥1 diagnostic code for NAFLD or NAFLD-like conditions, ≥1 order for anti-retroviral or hepatotoxic medications, or ≥1 diagnostic code for any of 27 non-NAFLD conditions that impact liver function.

Diagnostic Codes for NAFLD and NAFLD-like Conditions

Code Set	Code	Diagnosis Description	SNOMED Description	SNOMED Concept ID	SNOMED Concept Code
ICD-10	K76.0	Fatty (change of) liver, not elsewhere classified	Steatosis of liver	4059290	197321007
	K75.81	Nonalcoholic steatohepatitis (NASH)	Nonalcoholic steatohepatitis	40484532	442685003
	R94.5	Abnormal results of liver function studies	Liver function tests abnormal	438878	166603001
	R74.0	Nonspecific elevation of levels of transaminase and lactic acid dehydrogenase (LDH)	Elevated levels of transaminase & lactic acid dehydrogenase	436238	274774002
ICD-9	794.8	Nonspecific abnormal results of function study of liver	Hepatic function panel abnormal	4098153	26958001
				4135493	263654008
	790.4	Nonspecific elevation of levels of transaminase or lactic acid dehydrogenase	LDH blood measurement abnormal	4098519	250644007
				4135493	263654008
	571.8	Other chronic nonalcoholic liver disease	Chronic nonalcoholic liver disease	201613	79720007

Diagnostic Codes for Non-NAFLD Conditions That Impact Liver Function

ICD-9 Code	ICD-10 Code	Athena Description (if different or additional)	SNOMED Description	SNOMED Concept ID	SNOMED Concept Code
272.5	E78.6	Lipoprotein deficiency (or deficiencies)	Lipoprotein deficiency disorder	435516	267436001
571.1	K70.1	Acute alcoholic hepatitis	Alcoholic hepatitis	4340383	235875008
646.7	O26.61	Liver and biliary tract disorders in pregnancy	Liver disorder in pregnancy	194699	118185001
			Finding related to pregnancy	444094	15230009
			Disorder of pregnancy	439658	173300003
			Disease of the digestive system complicating pregnancy, childbirth and/or the puerperium	4062790	199294004
273.4	E88.01	Alpha-1-antitrypsin deficiency	Alpha-1-antitrypsin deficiency	192275	30188007

ICD-9 Code	ICD-10 Code	Athena Description (if different or additional)	SNOMED Description	SNOMED Concept ID	SNOMED Concept Code
759.89	Q44.7	Other congenital malformations of liver	Congenital anomaly of liver	444421	89166001
		Other specified congenital anomalies	Congenital disease	440508	66091009
571.2	K70.30	Alcoholic cirrhosis of liver	Alcoholic cirrhosis	196463	420054005
571.3	K70.9	Alcohol liver damage, unspecified	Alcohol liver damage	201612	41309000
303.xx	F10.2	Alcohol dependence	Alcohol dependence	435243	66590003
571.0	K70.0	Alcoholic fatty liver	Alcoholic fatty liver	193256	50325005
571.42	K75.4	Autoimmune hepatitis	Autoimmune hepatitis	200762	408335007
751.61	Q44.2, Q44.3	Atresia of bile ducts	Congenital biliary atresia	196796	77480004
579.0	K90.0	Celiac disease	Celiac disease	194992	396331005
576.8	K76.7	Other specified disorders of biliary tract	Disorder of biliary tract	197917	105997008
		Hepatorenal syndrome	Hepatorenal syndrome	196455	51292008
255.0	E24.2, E24.0	Drug-induced Cushing's syndrome	Iatrogenic Cushing's disease	4186577	41299009
277.00	E84.9	Cystic fibrosis without mention of meconium ileus	Cystic fibrosis	441267	190905008
275.1	E83.00, E83.01, E83.09	Disorder of copper metabolism or Wilson's disease	Disorder of copper metabolism	436672	79886009
			Wilson's disease	4229262	88518009
642.5x	O14.2	Severe pre-eclampsia or HELLP syndrome	Severe pre-eclampsia	433536	46764007
			HELLP syndrome	4316372	95605009
275.03	E83.119	Other hemochromatosis	Hemochromatosis	4163735	399187006
277.8x, 277.9		Other specified disorder of metabolism; Unspecified disorder of metabolism	Metabolic disease	436670	75934005
	E71.4, E88.9	Disorders of carnitine metabolism; Metabolic disorder, unspecified	Carnitine deficiency	4228429	421784001
272.6	E88.1	Lipodystrophy	Lipodystrophy	134324	71325002
V42.7	Z94.4	Liver replaced by transplant	Transplanted liver present	42537742	737297006
V58.69	Z76.0, Z79.891, Z79.899	Long-term (current) use of other medications	Long-term drug therapy	4141759	266713003
		Long-term (current) use of opiate analgesic; Encounter for issue of repeat prescription	Repeated prescription	4082397	182918009
260	E40	Protein-energy malnutrition (Kwashiorkor)	Kwashiorkor	432593	58262005
	R63.4	Abnormal weight loss	Abnormal weight loss	435928	267024001

ICD-9 Code	ICD-10 Code	Athena Description (if different or additional)	SNOMED Description	SNOMED Concept ID	SNOMED Concept Code
331.81	G93.7	Reye’s syndrome	Reye’s syndrome	375241	74351001
994.2	T73.0	Effects of hunger	Effects of hunger	433111	212966005
			Starvation	443082	212968006
70.x	B15	Acute hepatitis A	Acute type A viral hepatitis	4098652	25102003
	B16	Acute hepatitis B	Acute hepatitis B	197795	76795007
	B17	Other acute viral hepatitis	Acute viral hepatitis	4211974	57412004
	B18	Chronic viral hepatitis	Chronic viral hepatitis	4012113	10295004
	B19	Unspecified viral hepatitis	Viral hepatitis	4291005	3738000

Excluded Medications by Ingredient

Anti-Retroviral Medications		Other Hepatotoxic Medications
Atazanavir	Lamivudine	Amiodarone
Darunavir	Stavudine	Tamoxifen
Fosamprenavir	Tenofovir	Methotrexate
Indinavir	Zalcitabine	Tacrolimus
Lopinavir	Zidovudine	Valproate
Nelfinavir	Delavirdine	Cytosan
Ritonavir	Efavirenz	
Saquinavir	Etravirine	
Tipranavir	Nevirapine	
Abacavir	Enfuvirtide	
Didanosine	Maraviroc	
Emtricitabine	Raltegravir	

Table S2. Description of Diabetes Exclusions

The following International Classification of Diseases ICD-9 and ICD-10 diagnostic codes, procedure codes, and medications were used to exclude patients from the study population. Patients were excluded if they had ≥1 diagnostic code for diabetes, ≥1 order for diabetes medications, or ≥1 code for insulin pumps or continuous glucose monitors.

Diabetes Diagnostic Codes

Code Set	Code	Diagnosis Description	SNOMED Concept IDs
ICD-9	250.x	Diabetes mellitus	4196141, 37016767, 37016768, 4225656, 4221495, 43531578, 443735, 442793, 45769832, 43531616, 201820, 45757674, 45757474, 4096666, 4008576, 443238, 443727, 4009303, 373999, 435216, 443732, 443767, 42538169, 443733, 192279, 443730, 377821, 376065, 4202383, 43530690, 4223303, 4222876, 37016348, 37016349, 443592, 4226238, 201531, 201530, 45769876, 45757363, 4228112, 36714116, 439770, 443734, 4224254, 4228443, 4143857, 4140466, 45770830,
ICD-10	E08.x	Diabetes mellitus due to underlying condition	
	E09.x	Drug- or chemical-induced diabetes mellitus	
	E10.x	Type 1 diabetes mellitus	

	E11.x	Type 2 diabetes mellitus	380097, 37016179, 45757435, 37016180, 45770881, 4225055, 4222415, 45769830, 45763583, 43530656, 4131908, 318712, 443729, 321822, 37017431, 37017432, 45763584, 43530685, 200687, 443731, 4227210, 376114, 4290822, 45773064, 201254, 40484648, 4152858, 4096668, 4099214, 443412, 201826, 4099217, 4151282, 4198296, 4200875, 4099651, 4193704, 40482801, 45770902
	E13.x	Other specified diabetes mellitus	

Excluded Diabetes Medications by Ingredient

Ingredient	
Acarbose	Linagliptin
Alogliptin	Metformin ^a
Bromocriptine	Miglitol
Canagliflozin	Nateglinide
Chlorpropamide	Pioglitazone
Dapagliflozin	Repaglinide
Empagliflozin	Rosiglitazone
Ertugliflozin	Saxagliptin
Glimepiride	Semaglutide
Glipizide	Sitagliptin
Glyburide	Tolazamide
Insulin	Tolbutamide
^a If patients had orders for only metformin (i.e., not in combination with another ingredient), they were not excluded since metformin is also used to treat obesity.	

Codes for Insulin Pumps and Continuous Glucose Monitors

Vocabulary	Code	Diagnosis Description
CPT4	95249, 95250, 95251	Ambulatory continuous glucose monitoring
HPCS	A9276, A9277, A9278, K0553	Supplies for continuous glucose monitor, including sensor and receiver

HCPCS	S5565, S5566, A4230, A4231, A4232, A4255, E0784	Supplies for insulin pump, including insulin cartridge and infusion set
HCPCS	S1034	Artificial pancreas device system
HCPCS	J1817	Insulin for administration through DME (i.e., insulin pump) per 50 units
SNOMED	180178009, 443263006	Continuous subcutaneous infusion of insulin or insertion of insulin pump
SNOMED	69805005, 767696004, 767697008, 463326009, 470153003, 701419004, 701718008, 469277009, 468217005, 770744007	Insulin pump, ambulatory insulin infusion pump supplies, and related devices
NDC	15630004884, 15630005235, 15630088435-15630088443, 38384300100, 65781012410, 65781025001, 65781025101, 65781025201, 65781037001, 65781037101, 65781037201, 65781118110, 76300012201, 76300022201, 76300032610, 76300033210, 76300039710, 76300039910, 76300052201, 89110512304, 89110512704, 89110514304, 89110514704, 89110522604, 89110522904, 89110524604, 89110524904, 89110711101, 89110711102, 89152338005, 89152462901	Insulin pump kit, cartridge, infusion set, insulin pump controllers, and related devices
ICD-9	V53.91	Fitting and adjustment of insulin pump
ICD-10	Z96.41	Presence of insulin pump
ICD-9 ICD-10	996.57, T85.614x, T85.624x, T85.633x, T85.694x, T85.72x	Breakdown, leakage, displacement, other mechanical complication of, or infection and inflammatory reaction due to insulin pump

Abbreviations: CPT, Current Procedural Terminology; DME, durable medical equipment; HCPCS, Healthcare Common Procedure Coding System; ICD, International Classification of Diseases; NDC, National Drug Code.

Table S3. Description of Dyslipidemia Exclusions
The following International Classification of Diseases ICD-10 and SNOMED diagnostic codes and medications were used to exclude patients from the study population. Patients were excluded if they had ≥1 diagnostic code for dyslipidemia or familial lipid disorders or ≥1 order for medications to treat dyslipidemia (i.e., statins).

Diagnostic Codes for Dyslipidemia

SNOMED Description	SNOMED Concept ID	SNOMED Concept Code	ICD-10 Equivalent
Atherogenic lipoprotein phenotype	4186703	413596002	
Decreased lipoprotein	4050599	124041005	

Dyslipidemia with high density lipoprotein below reference range and triglyceride above reference range due to type 2 diabetes mellitus	45757280	111231000119109	
Elevated cholesterol/high-density lipoprotein ratio	4208912	439953004	
Exogenous hyperlipidemia	4030586	129590000	
High-density lipoprotein above reference range	40483651	443835004	
High-density lipoprotein deficiency	40491984	448834003	
Hypercholesterolemia	4029305	13644009	
Hypercholesterolemia well controlled	40484632	444059002	
Hyperlipidemia	432867	55822004	E78.4, E78.49, E78.5
Hyperlipidemia due to type 1 diabetes mellitus	45757432	137941000119106	
Hyperlipidemia due to type 2 diabetes mellitus	45770880	137931000119102	
Hyperlipidemia with lipid deposition in skin	4298723	402725005	
Hyperlipoproteinemia	4292079	3744001	
Hypertriglyceridemia	4120314	302870006	
Increased lipoprotein	4047805	124040006	E78.41
Mixed hypercholesterolemia and hypertriglyceridemia	4030619	129591001	
Mixed hyperlipidemia	438720	267434003	E78.2
Mixed hyperlipidemia due to type 1 diabetes mellitus	43530660	1571000119104	
Mixed hyperlipidemia due to type 2 diabetes mellitus	43531651	701000119103	
Secondary combined hyperlipidemia	4079887	238089003	
Secondary hypercholesterolemia	4029891	238082007	
Secondary hyperlipidemia	4292672	402727002	
Secondary hypertriglyceridemia	4029892	238087001	
Very low-density lipoproteinemia	4031947	238084008	

Diagnostic Codes for Familial Hypercholesterolemia

SNOMED Description	SNOMED Concept ID	SNOMED Concept Code	ICD-10 Equivalent
Pure hypercholesterolemia	437827	267432004	E78.0, E78.00
Primary hypercholesterolemia	4031945	238076009	
Secondary hypercholesterolemia	4029891	238082007	
Polygenic hypercholesterolemia	4029258	238077000	
Familial hypercholesterolemia	4134862	398036000	E78.01
Familial hypercholesterolemia – heterozygous	4029259	238079002	
Familial hypercholesterolemia – homozygous	4079885	238078005	
Familial hypercholesterolemia due to heterozygous LDL receptor mutation	4295608	403829002	

Familial hypercholesterolemia due to genetic defect of apolipoprotein B	4295609	403831006	
Familial hypercholesterolemia due to homozygous LDL receptor mutation	4298010	403830007	
Double heterozygous familial hypercholesterolemia	35608140	767133009	

Abbreviation: LDL, low-density lipoprotein.

Diagnostic Codes for Other Familial Lipid Disorders

SNOMED Description	SNOMED Concept ID	SNOMED Concept Code
Chylomicronemia syndrome	4294296	402786009
Disorder of lipoprotein AND/OR lipid metabolism	4170226	48286001
Disorder of lipoprotein storage and metabolism	4031814	238037008
Endogenous hyperlipidemia	4030618	129589009
Familial apolipoprotein C-II deficiency	4143177	33513003
Familial combined hyperlipidemia	4079876	238040008
Familial defective apolipoprotein B-100	4029890	238081000
Familial hyperalphalipoproteinemia	45757500	15771000119109
Familial hyperchylomicronemia	437521	267435002
Familial hyperlipoproteinemia	4029119	238038003
Familial hypertriglyceridemia	4142496	34528009
Familial lipoprotein deficiency	4177976	49973006
Familial lipoprotein lipase deficiency with type I phenotype	4301409	403827000
Familial lipoprotein lipase deficiency with type V phenotype	4300461	403828005
Familial multiple lipoprotein-type hyperlipidemia	4104485	299465007
Familial type 3 hyperlipoproteinemia	4162681	398796005
Familial type 5 hyperlipoproteinemia	4144529	34349009
Fredrickson type IIa hyperlipoproteinemia	4220010	397915002
Fredrickson type IV hyperlipoproteinemia	4029261	238085009
Hyperalphalipoproteinemia	4079886	238080004
Hypercholesterolemia due to cholesterol 7alpha-hydroxylase deficiency	36674388	773726000
Hyperlipidemia, group A	4096215	190774002
Hyperlipoproteinemia	4292079	3744001
Hyperlipoproteinemia, type I	4077382	275598004
Lipoprotein deficiency disorder	435516	267436001
Primary "polygenic" combined hyperlipidemia	4270878	402474007
Primary acquired chylomicronemia	4223495	402475008
Primary chylomicronemia	4291436	402726006
Primary combined hyperlipidemia	4029263	238088006
Primary genetic mixed hyperlipidemia	4294297	402787000
Primary hypertriglyceridemia	4029260	238083002

Pure hyperglyceridemia	440360	267433009
Sporadic primary hypertriglyceridemia	4299409	402473001

Excluded Dyslipidemia Medications by Ingredient

Ingredient
Atorvastatin
Cerivastatin
Fluvastatin
Lovastatin
Pitavastatin
Pravastatin
Rosuvastatin
Simvastatin

Table S4. Codes for Pediatric Preventive (Well-Child) Care

Vocabulary	Code	Code Description
CPT4	99381, 99382, 99383, 99384, 99385	Initial comprehensive preventive medicine evaluation and management of an individual including an age and gender appropriate history, examination, counseling/anticipatory guidance/risk factor reduction interventions, and the ordering of laboratory/diagnostic procedure
	99391, 99392, 99393, 99394, 99395	Periodic comprehensive preventive medicine reevaluation and management of an individual including an age and gender appropriate history, examination, counseling/anticipatory guidance/risk factor reduction interventions, and the ordering of laboratory/diagnostic procedure
SNOMED	410620009, 410629005, 410631001, 410632008,	Well-child visit (ages 12 months through 18 years)

	410633003, 410634009, 410636006, 410637002, 410638007, 410639004, 410640002, 410641003, 410642005, 410643000, 410644006, 410645007, 410646008, 410647004, 410648009, 410649001, 410650001	
SNOMED	243788004, 310367004, 268563000, 171417004	Child examination Child examination/reports/meeting status Child health medical examination Pre-school child health examination

Abbreviation: CPT, Current Procedural Terminology.