

# DOHMH Roadmap: DALY and Cost Estimates

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# DOHMH Roadmap: DALY Estimates

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## Background

### Objective

The objective of this analysis is to estimate DALYs lost and economic losses in New York City due to the following major categories of conditions (with about 100 conditions in total within these categories):

- Major depression
- Alcohol use
- Marijuana use
- Heroin use
- Cocaine use
- Stimulant use
- Sedative use
- Tranquilizer use

It will not be possible to estimate economic losses for all 100 conditions because of inadequate data. As such, marijuana, heroin, cocaine, stimulant, sedative, and tranquilizer use are included in two alternate major categories of conditions:

- Illicit drug use
- Non-medical use of prescription opioids

## DALYs

### Definition of Key Terms

#### DALY

**Disability-adjusted life years.** The DALY is a year of life lived in perfect health and consists of two elements: YLLs and YLDs. The DALY is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

$$\text{DALY} = \text{YLL} + \text{YLD}$$

## YLL

**Years of life lost.** Years of life lost is an estimate of the average years a person would have lived if he or she had not died prematurely.

$$\text{YLL} = (\text{Number of deaths}) * (\text{Standard life expectancy at age of death in years})$$

## YLD

**Years of life lost due to disability.** This is the morbidity component of the DALY score. To estimate YLD for a particular cause in a particular time period, the number of incident cases in that period is multiplied by the average duration of the disease and a weight factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (dead). The basic formula for YLD is the following:

$$\text{YLD} = (\text{number of incident cases}) * (\text{disability weight}) * (\text{average duration of disease})$$

## Methods

### Data Sources

- 2013 NYCHANES - prevalence estimates
- 2002-2008 NSDUH - drug use prevalence estimates
- 2013 NYC Vital Statistics - mortality estimates
- 2010 Global Burden of Disease Study - national YLD/YLL rates
- 2013 NYC American Community Survey - population estimates

The challenge with using NYCHANES and NSDUH data to estimate the prevalence of a condition is that the n may be too small. To increase their utility of these surveys, we will aggregate age groups into the following strata: childhood (0-14), late adolescence/early adulthood (15-24), adulthood (25-64), and later life (65+).

## DALY Estimation

### YLLs

To estimate compute NYC YLLs, we will use NYC mortality counts stratified by age, sex, and race. In concordance with the literature on DALY estimation, life expectancy estimates based on the life expectancy in Japan (82.5 years for women and 80.0 years for men) were used for the calculation of YLL. In order to remain consistent with the methodology of the 2010 Global Burden Disease Study, no age weighting or discounting was applied.

### YLDs

To compute NYC YLDs, we will use the two approaches described below:

## 2005 NYC DOHMH / Michaud (2006)

In order to compare the magnitude of the DALY scores to the [2005 NYC DOHMH study](#), we will replicate the previous study's methodology, which was based on [Michaud CM, et al.](#) The burden of disease and injury in the United States 1996. Population Health Metrics 2006,4:11.

"For NYC YLD, U.S. Census Bureau population estimates for New York City in 2005 by sex were used to calculate years lived with disability (YLD) by applying national YLD rates and ratios from the Michaud et al. study. If the national YLL:YLD ratio was less than 10, then the NYC YLD was equal to the national YLD:YLL ratio multiplied by NYC YLL. If the national YLD:YLL ratio was greater than or equal to 10 (producing unreliable City estimates), then NYC YLD was equal to the national YLD rate multiplied by the NYC population."

Implementing the Michaud approach will thus require the following data elements:

- NYC Population by age, sex
- National YLD rates by age, sex
- NYC YLLs by age, sex

In order to remain consistent with the demographic weighting approach used by NYC DOHMH for the 2013 NYCHANES data, NYC population estimates were obtained from the [2013 American Community Survey](#), which is available on the NYC Department of City Planning website. Since the data from the Michaud study are from 1996 and patterns of disease and disability have changed, we will update the approach using national YLD/YLL rates from the 2010 Global Burden of Disease Study.

## Prevalence-based YLDs

Years lived with a disability (YLD) due to each disease can be calculated on the basis of either the incidence or the prevalence of the disease. The initial GBD studies estimated YLD on the basis of the incidence of each disease. Thus, in the 1990 study for example, the YLD estimates measured the future loss of health resulting from disease episodes that began in 1990. One advantage of this approach is that it is consistent with that used for mortality: YLL measure the future loss of life resulting from deaths in a particular year.

The 2010 GBD study adopted the alternative approach and calculated YLD based on the prevalence of the impairments resulting from each disease in the year for which the estimates are made. This approach has the advantage that it assigns YLD to the ages at which they are lived, rather than to the age at which the disease episode that produced them began.

Because prevalence is approximately incidence x duration, prevalence YLD for a condition (across all ages) is approximately the same as the no frills incidence YLD. As such, we can estimate YLDs using the following formula:

$$\text{YLD} = (\text{number of prevalent cases}) * (\text{disability weight})$$

We can estimate the number of prevalent cases for each condition using survey data from 2013 NYCHANES. Annual prevalence for drug use can be estimated using data from 2002-2008 NSDUH. Disability weights can be extracted from the 2010 Global Burden of Disease study. However, we should note that the prevalence YLD for a condition may be quite different in magnitude to the incidence-

based YLD, depending on how age weighting and discounting are applied. As such, comparisons to previous NYC DALY studies should be done with caution.

Further information about estimating DALYs can be found from the Global Burden of Disease concept paper ([WHO, 2006](#)).

## **Disease Rankings**

Since our goal is to communicate the burden of diseases in New York City, we will rank each condition in decreasing order of the DALY score. We will also test the stability of the rankings by comparing the results generated from the Michaud approach and the prevalence-based YLDs approach. Moreover, since the 2010 GBD study also provides 95% confidence intervals around point estimates for disability weights and national YLD/YLL rates, further stability checks can be conducted by reporting DALY estimations with their respective upper and lower bounds.

However, we should note that since the DALY estimations are not inclusive of all disease conditions, we will not be able to report our findings as the "top X conditions contributing to DALYs." Instead, we can only report mental health DALYs in reference to other highly prevalent chronic diseases.

## **Estimation of Substance Use Dependence**

Prevalence estimates of substance use cannot be directly substituted for prevalence of drug dependence or abuse disorders. We make the following assumptions about the average proportion of dependence among users ([National Addiction Centre, 2003](#)):

- Alcohol - 15.4%
- Cocaine - 16.7%
- Heroin - 23.1%
- Cannabis - 9.1%

## **Estimation of Major Depressive Disorder Using PHQ-9**

Prevalence estimates for 2-week depression was obtained for 2013 NYCHANES. While 2-week depression prevalence would lead to underestimation of 1-year depression, the use of PHQ-9 scores can also overestimate both MDD and any depressive disorder due to its low positive predictive value (~55%) for PHQ-9 scores below 10, the cutoff between mild and moderate depression ([Kroenke, 2002](#)). To adjust for this in the prevalence-based YLD approach, we did not consider PHQ-9 scores below 10 and assumed - from expert opinion - that only half of those with PHQ-9 scores above 10 were actually diagnosed with MDD.

## **Sensitivity Analysis**

In order to validate the Michaud approach, we will use 2005 NYC mortality estimates from the previous DOHMH to test the stability of our DALY rankings. However, since age-weighting is no longer used by the 2010 GBD due to ethical concerns, we suspect the magnitude of 2013 NYC DALYs to be slightly higher than that of the 2005 NYC DALYs.

## DALY Estimation

### Michaud YLD Approach

This section contains an implementation of the Michaud approach described in the above methods section. We first create a search index containing all the disease conditions of interest.

This search index is then fed through the calculateDALY workhorse function to estimate DALYs for each disease condition. The result is a data.frame object containing the following columns: cause\_name, sex, yll, yld, yld\_upper, yld\_lower, daly, daly\_upper, daly\_lower.

### Prevalence-Based YLD Approach

Similar to the section, we implement the prevalence-based YLD approach here using the same search index.

## Results

### Michaud YLD Approach

Raw results for this approach can be found under the results directory under the filename nyc\_daly\_michaud.csv. The file can be opened in Excel and manipulated with a pivot table for aggregation and stratification purposes.

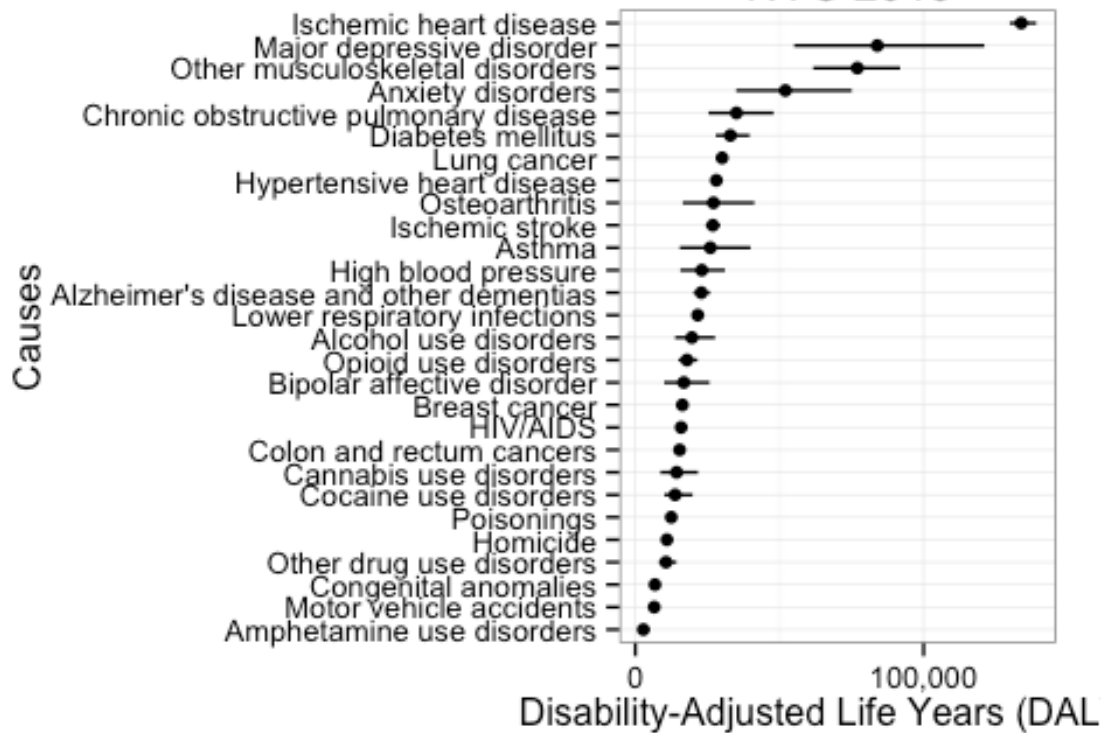
### 2013 NYC DALY Estimates, Total

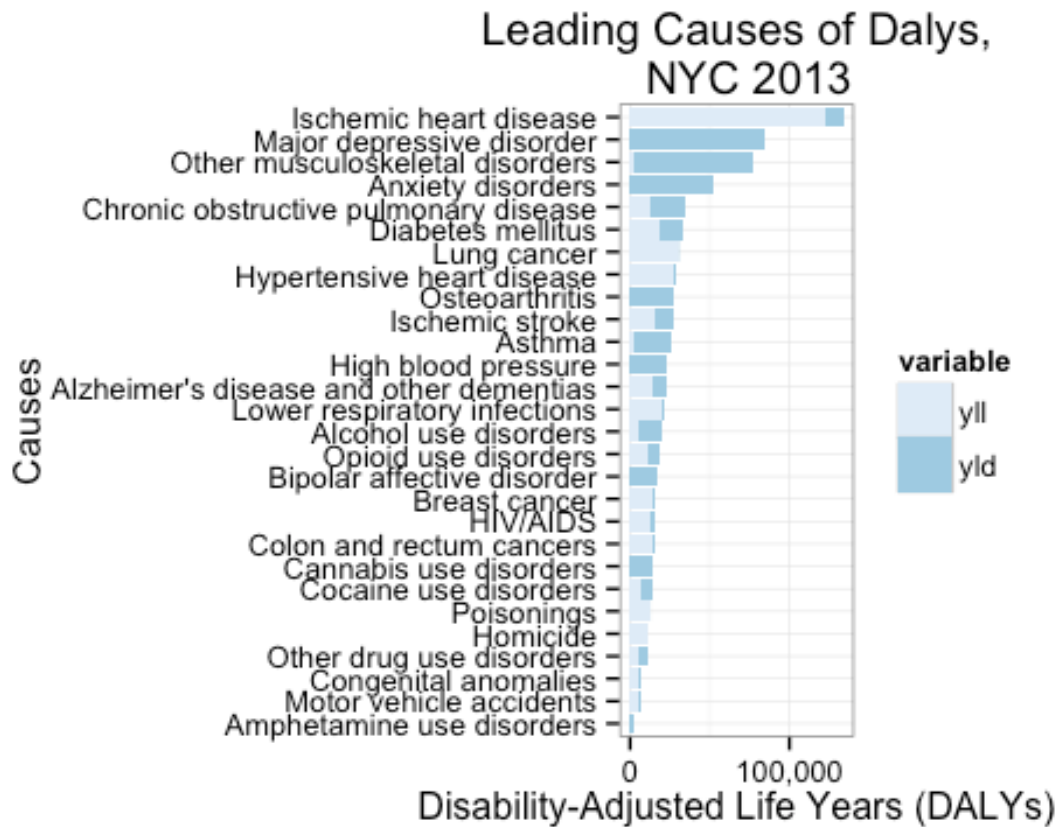
cause_name	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	122326	11569	16786	7589	133895	139112	129915
Major depressive disorder	0	83953	121100	55076	83953	121100	55076
Other musculoskeletal disorders	2837	74190	89035	58823	77027	91872	61660
Anxiety disorders	0	52051	75105	34951	52051	75105	34951
Chronic obstructive pulmonary disease	13123	21960	34847	12251	35083	47970	25374
Diabetes mellitus	17984	15001	21700	9912	32985	39684	27896
Lung cancer	29658	449	791	211	30107	30449	29869
Hypertensive heart disease	27201	891	1549	429	28092	28749	27630
Osteoarthritis	129	26968	41201	16316	27097	41330	16445
Ischemic stroke	15957	10924	13521	8485	26881	29478	24443
Asthma	2863	23162	37090	12510	26025	39953	15373
High blood pressure	0	23051	31082	15615	23051	31082	15615
Alzheimer's disease and	13613	9286	12343	6555	22899	25956	20168

other dementias							
Lower respiratory infections	20554	1095	1661	671	21649	22215	21225
Alcohol use disorders	4673	14942	22992	9083	19615	27665	13757
Opioid use disorders	10654	7272	10935	4299	17925	21588	14953
Bipolar affective disorder	0	16820	25727	10012	16820	25727	10012
Breast cancer	13773	2548	3856	1647	16321	17629	15420
HIV/AIDS	13117	2764	4487	1422	15881	17604	14539
Colon and rectum cancers	14377	985	1645	567	15362	16022	14944
Cannabis use disorders	0	14303	21780	8642	14303	21780	8642
Cocaine use disorders	6738	7054	13145	3321	13792	19883	10059
Poisonings	12390	69	182	10	12459	12573	12400
Homicide	10945	NA	NA	NA	10945	NA	NA
Other drug use disorders	5373	5245	8900	2829	10619	14273	8202
Congenital anomalies	5752	1049	1648	631	6801	7400	6383
Motor vehicle accidents	5318	1224	1846	783	6542	7163	6100
Amphetamine use disorders	0	2773	4845	1347	2773	4845	1347



## Leading Causes of Dalys, NYC 2013





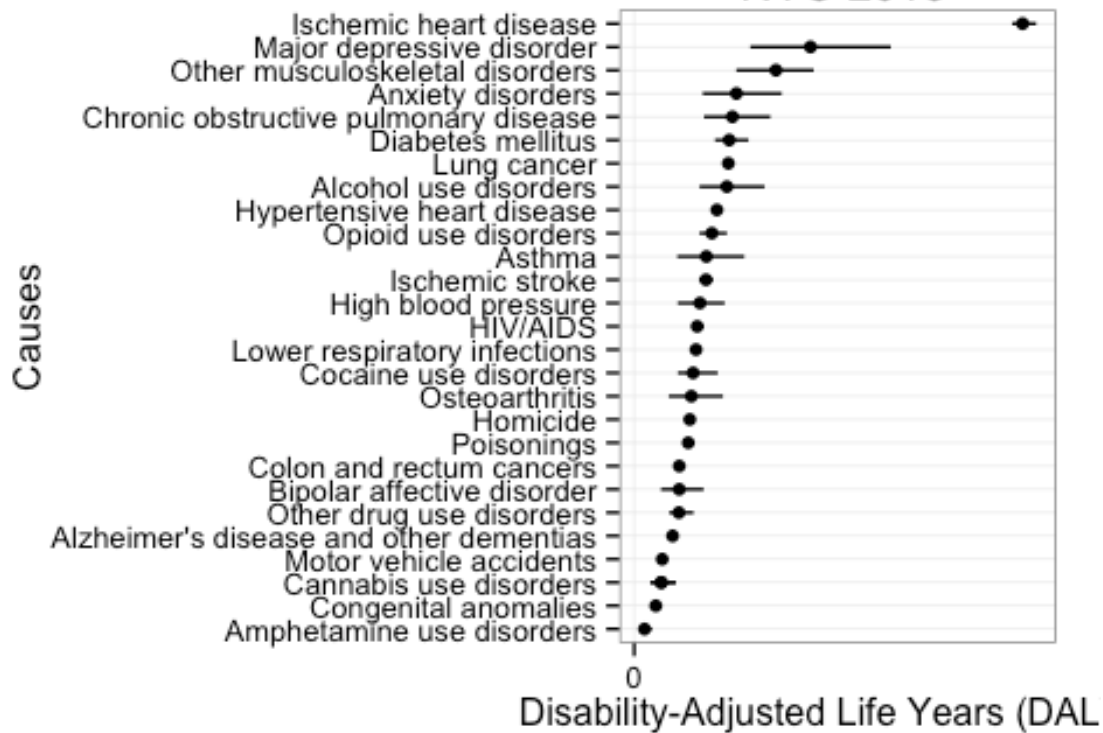
- Ischemic heart disease is the leading cause of disease in 2013, but has a wide range of uncertainty
- Disaggregated drug use disorders ranked relatively low, particularly for non-alcohol-related substances
- Major depressive disorder just missed the top 10 cutoff

### 2013 NYC DALY Estimates, Male

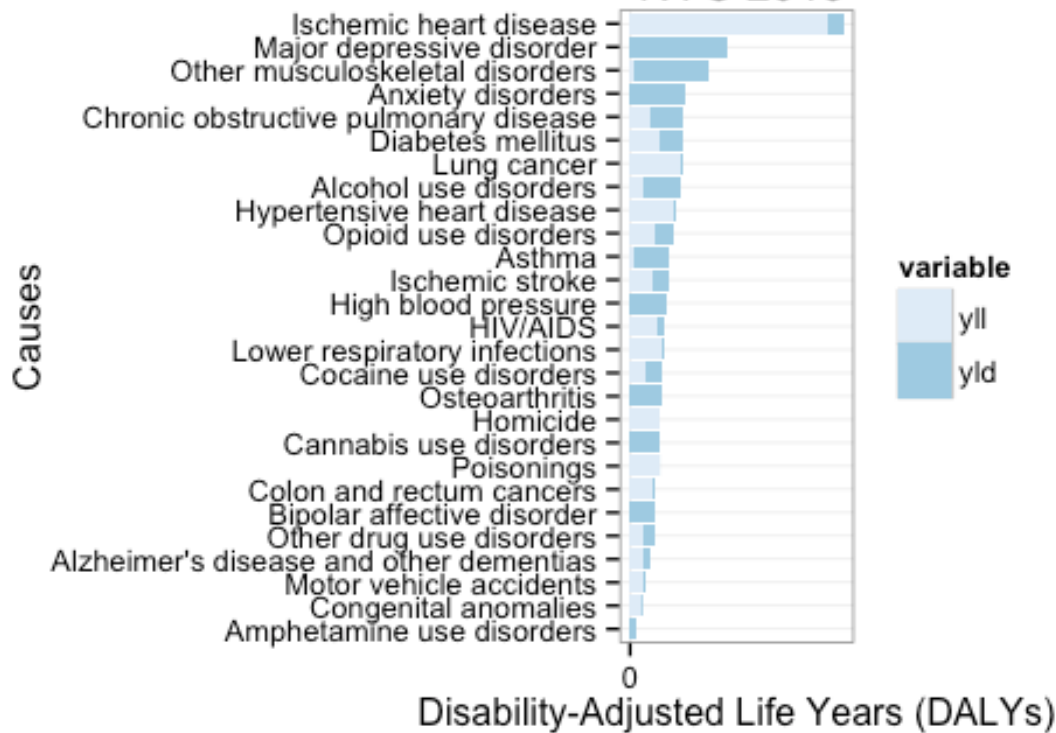
cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	Male	59171	4986	7246	3254	64158	66417	62425
Major depressive disorder	Male	0	29122	42380	19172	29122	42380	19172
Other musculoskeletal disorders	Male	971	22446	28679	15890	23417	29650	16861
Anxiety disorders	Male	0	16888	24380	11291	16888	24380	11291
Chronic obstructive pulmonary disease	Male	5818	10412	16696	5717	16229	22514	11535
Diabetes mellitus	Male	8870	6836	10019	4468	15706	18889	13338

Lung cancer	Male	15346	215	367	110	15560	15713	15456
Alcohol use disorders	Male	3694	11614	17842	7105	15308	21536	10799
Hypertensive heart disease	Male	13357	310	555	145	13668	13912	13503
Opioid use disorders	Male	7701	5136	7623	3096	12837	15324	10797
Asthma	Male	1464	10463	16739	5641	11927	18203	7105
Ischemic stroke	Male	6876	4987	6197	3854	11863	13073	10730
High blood pressure	Male	0	10872	14946	7183	10872	14946	7183
HIV/AIDS	Male	8508	1906	3004	1036	10413	11512	9543
Lower respiratory infections	Male	9756	463	710	279	10219	10466	10035
Cocaine use disorders	Male	4910	4824	8895	2304	9734	13805	7214
Osteoarthritis	Male	62	9384	14597	5661	9445	14658	5722
Homicide	Male	9185	NA	NA	NA	9185	NA	NA
Poisonings	Male	8881	53	134	9	8934	9015	8890
Colon and rectum cancers	Male	7021	432	712	250	7452	7733	7271
Bipolar affective disorder	Male	0	7449	11473	4414	7449	11473	4414
Other drug use disorders	Male	3874	3519	5948	1914	7393	9823	5789
Alzheimer's disease and other dementias	Male	3823	2529	3391	1788	6352	7215	5612
Motor vehicle accidents	Male	3805	830	1252	533	4634	5057	4338
Cannabis use disorders	Male	0	4486	6858	2705	4486	6858	2705
Cannabis use disorders	Male	0	4486	6858	2705	4486	6858	2705
Congenital anomalies	Male	3042	537	834	325	3579	3877	3367
Amphetamine use disorders	Male	0	1711	2950	839	1711	2950	839

## Leading Causes of DALYs in M NYC 2013



## Leading Causes of DALYs in Males, NYC 2013



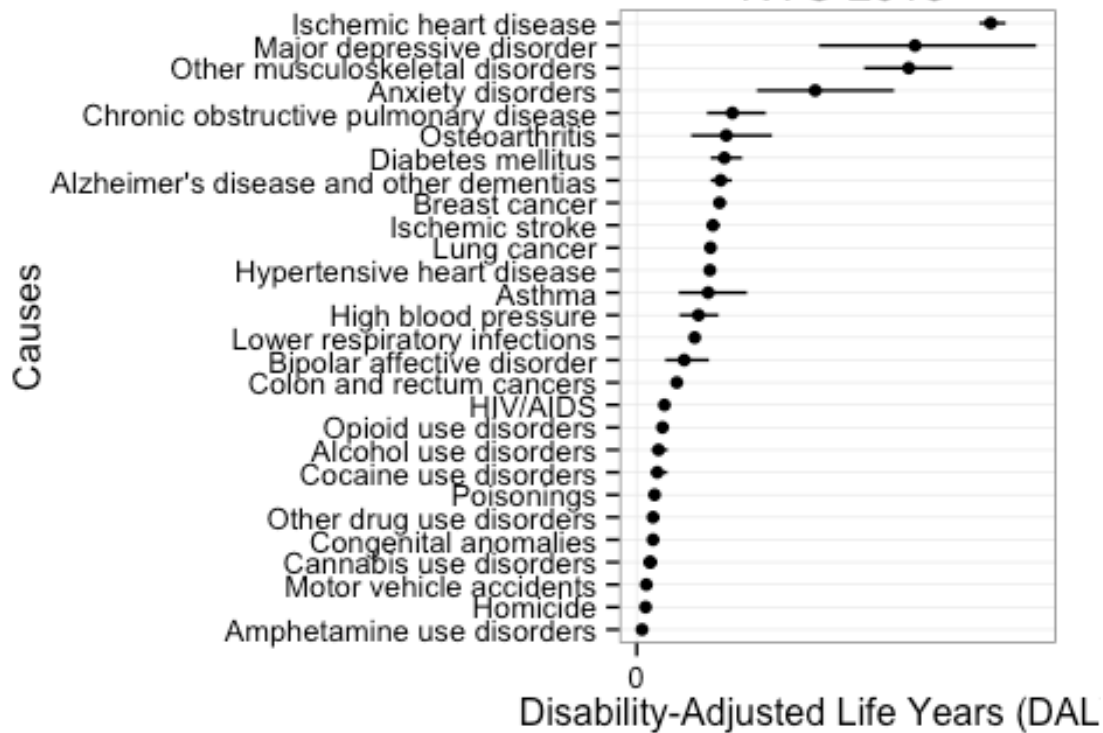
- Alcohol use disorders rises to the #4 slot
- Homicide and accidental deaths such as poisonings and motor vehicle accidents rise in rankings

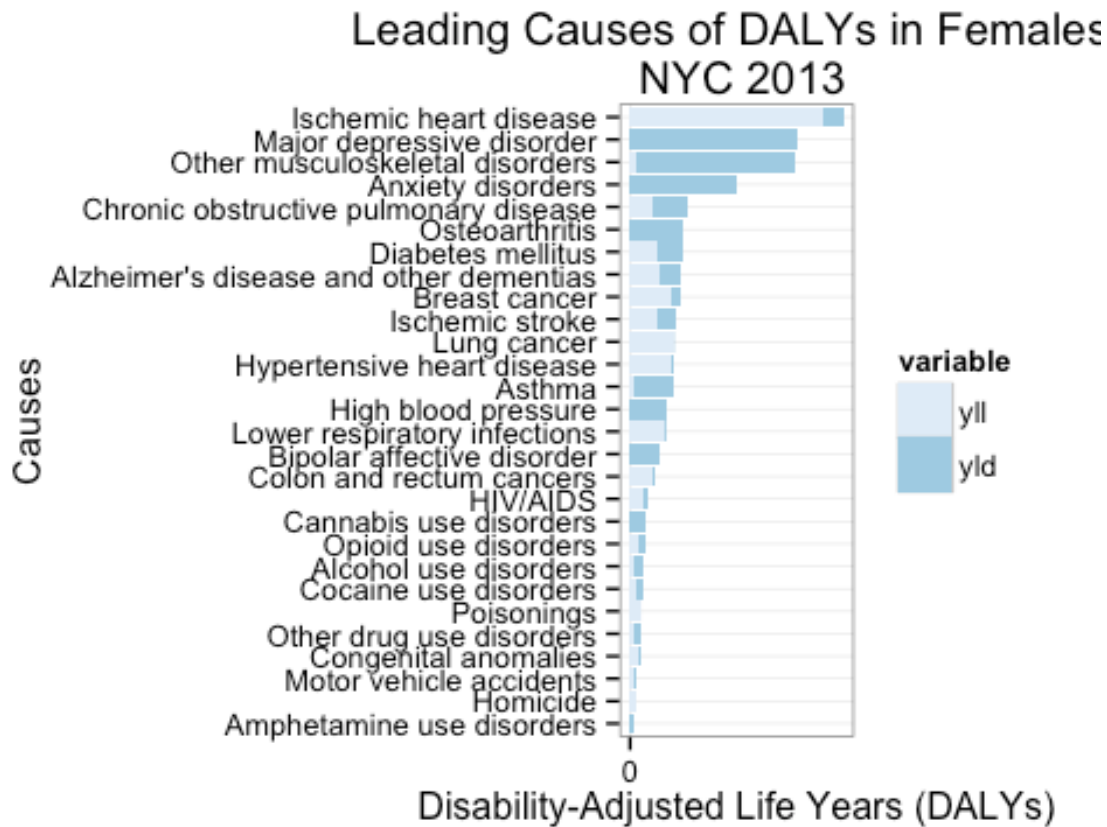
## 2013 NYC DALY Estimates, Female

cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	Female	63155	6582	9540	4335	69737	72695	67490
Major depressive disorder	Female	0	54832	78719	35904	54832	78719	35904
Other musculoskeletal disorders	Female	1866	51743	60357	42933	53609	62223	44799
Anxiety disorders	Female	0	35163	50725	23660	35163	50725	23660
Chronic obstructive pulmonary disease	Female	7306	11548	18151	6534	18854	25457	13840
Osteoarthritis	Female	67	17585	26605	10655	17652	26672	10722

Diabetes mellitus	Female	9114	8165	11681	5444	17279	20795	14558
Alzheimer's disease and other dementias	Female	9790	6757	8951	4767	16547	18741	14557
Breast cancer	Female	13773	2548	3856	1647	16321	17629	15420
Ischemic stroke	Female	9081	5937	7324	4632	15018	16405	13713
Lung cancer	Female	14313	234	424	100	14547	14737	14413
Hypertensive heart disease	Female	13843	581	994	284	14424	14837	14127
Asthma	Female	1399	12699	20350	6869	14099	21750	8268
High blood pressure	Female	0	12180	16136	8433	12180	16136	8433
Lower respiratory infections	Female	10798	632	951	391	11430	11748	11189
Bipolar affective disorder	Female	0	9371	14254	5598	9371	14254	5598
Colon and rectum cancers	Female	7356	554	933	317	7910	8289	7673
HIV/AIDS	Female	4609	859	1483	386	5468	6092	4995
Opioid use disorders	Female	2953	2135	3311	1203	5088	6264	4156
Alcohol use disorders	Female	980	3327	5149	1978	4307	6129	2958
Cocaine use disorders	Female	1828	2230	4250	1017	4058	6078	2845
Poisonings	Female	3509	16	48	1	3525	3557	3510
Other drug use disorders	Female	1499	1726	2951	915	3225	4450	2413
Congenital anomalies	Female	2710	513	814	305	3222	3524	3015
Cannabis use disorders	Female	0	2665	4032	1616	2665	4032	1616
Cannabis use disorders	Female	0	2665	4032	1616	2665	4032	1616
Motor vehicle accidents	Female	1513	394	594	249	1907	2107	1762
Homicide	Female	1760	NA	NA	NA	1760	NA	NA
Amphetamine use disorders	Female	0	1062	1895	508	1062	1895	508

## Leading Causes of DALYs in Fer NYC 2013





- Breast cancer makes the top 3
- Alzheimer's disease and other dementias ranks very high
- Drug-related disorders get pushed to the bottom

## Prevalence-Based YLD Approach

Raw results for this approach can be found under the results directory under the filename `nyc_daly_prevalence.csv`. The file can be opened in Excel and manipulated with a pivot table for aggregation and stratification purposes.

### 2013 NYC DALY Estimates, Total

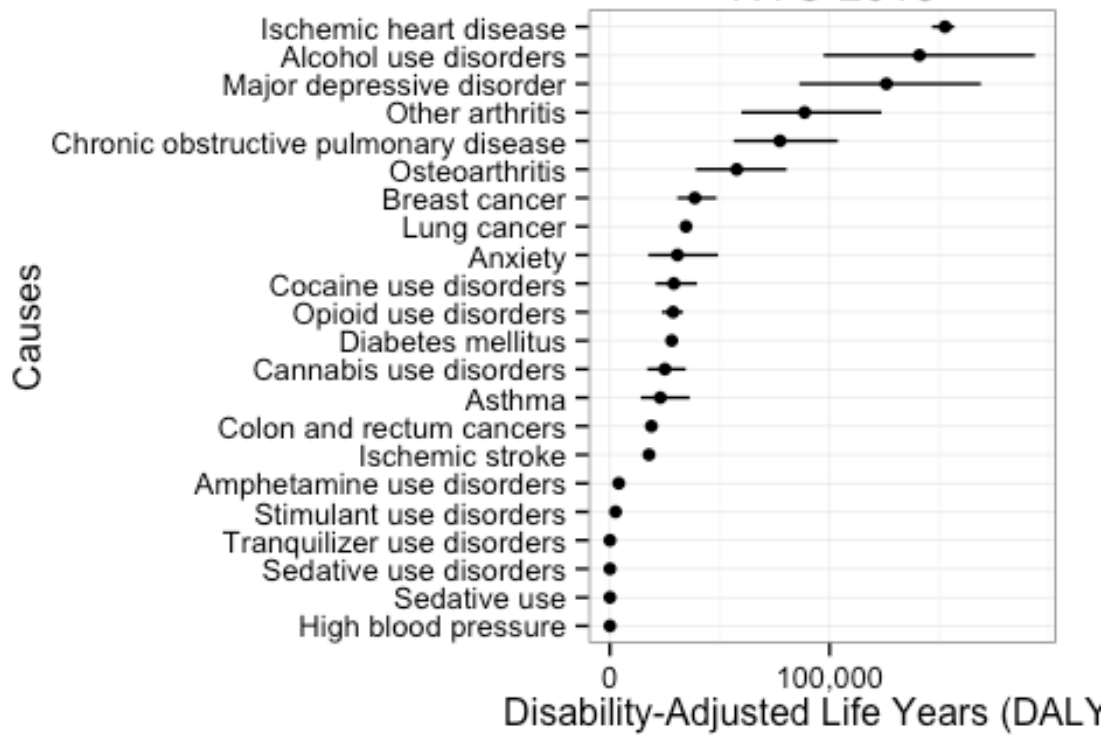
cause_name	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	122326	30186	34498	24197	152512	156824	146523
Alcohol use disorders	4673	136164	188737	92528	140837	193410	97202
Major depressive disorder	NA	125830	168883	86154	125830	168883	86154
Other arthritis	NA	88591	123561	59838	88591	123561	59838
Chronic obstructive pulmonary disease	13123	64253	90690	43170	77376	103813	56293
Osteoarthritis	129	57587	80319	38896	57716	80447	39025

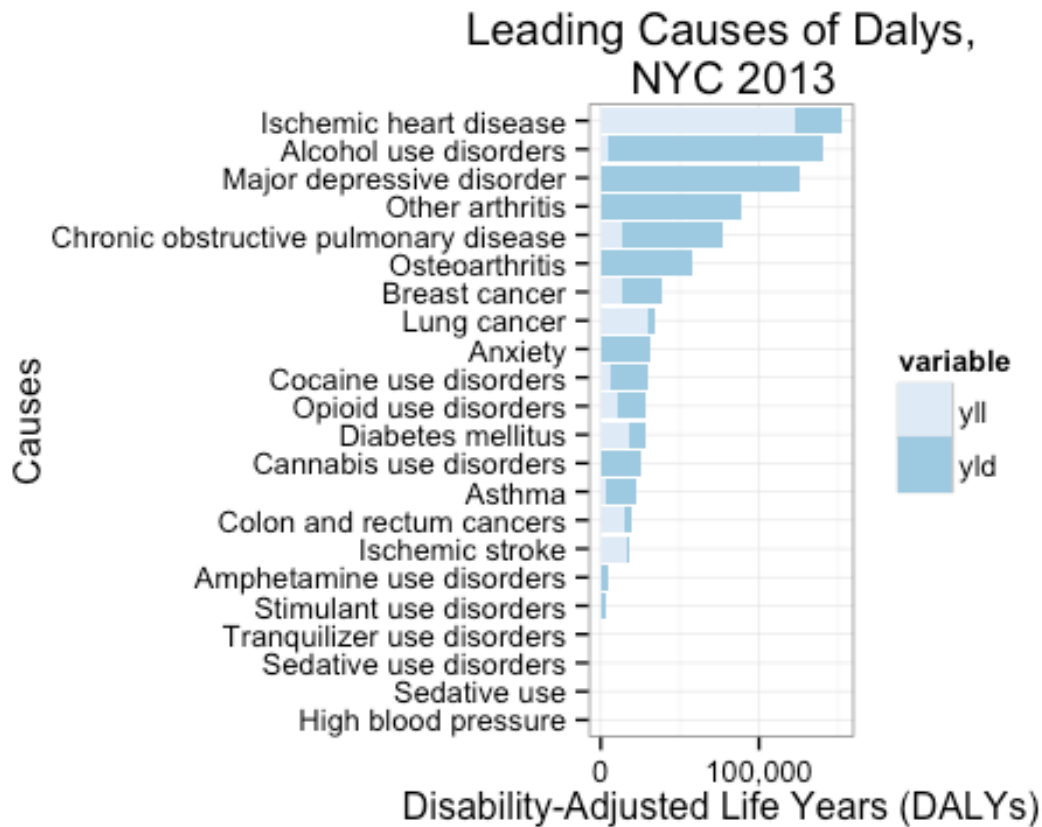


Breast cancer	13873	24769	34626	16765	38642	48499	30638
Lung cancer	29664	4937	6902	3342	34602	36567	33006
Anxiety	NA	30752	49203	17426	30752	49203	17426
Cocaine use disorders	6738	22333	32846	13958	29071	39584	20696
Opioid use disorders	10654	18069	22636	12939	28723	33290	23593
Diabetes mellitus	17984	10119	12143	8095	28104	30127	26080
Cannabis use disorders	NA	24991	34562	16939	24991	34562	16939
Asthma	2863	20058	33430	11143	22922	36294	14007
Colon and rectum cancers	14383	4471	6251	3027	18854	20634	17409
Ischemic stroke	15957	1820	3207	953	17777	19164	16911
Amphetamine use disorders	NA	4025	5986	2451	4025	5986	2451
Stimulant use disorders	NA	2549	3790	1552	2549	3790	1552
High blood pressure	NA	0	0	0	0	0	0
Sedative use	NA	0	0	0	0	0	0
Sedative use disorders	NA	0	0	0	0	0	0
Tranquilizer use disorders	NA	0	0	0	0	0	0

- Major depressive disorder ranks number one, beating out the number two slot by almost twice the number of DALYs. However, DALY estimates appear to be unstable, taking a wide range of possible values.
- Not enough information to calculate DALY estimates for sedative use, stimulant use, tranquilizer use.

## Leading Causes of Dalys, NYC 2013



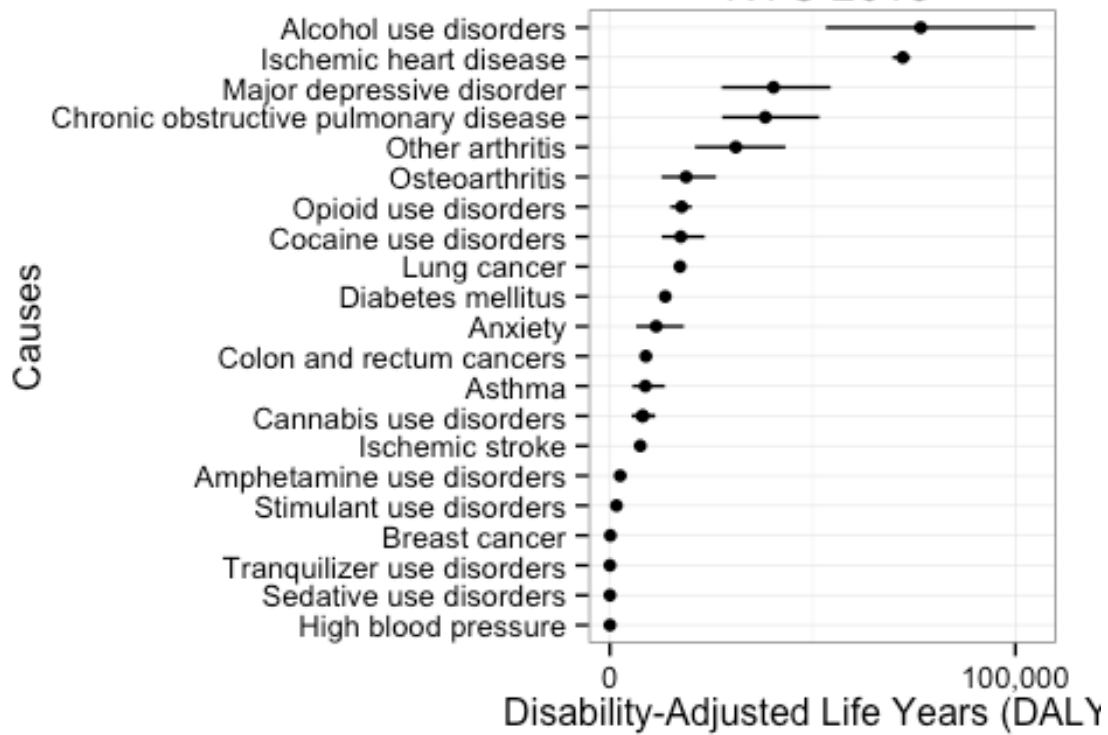


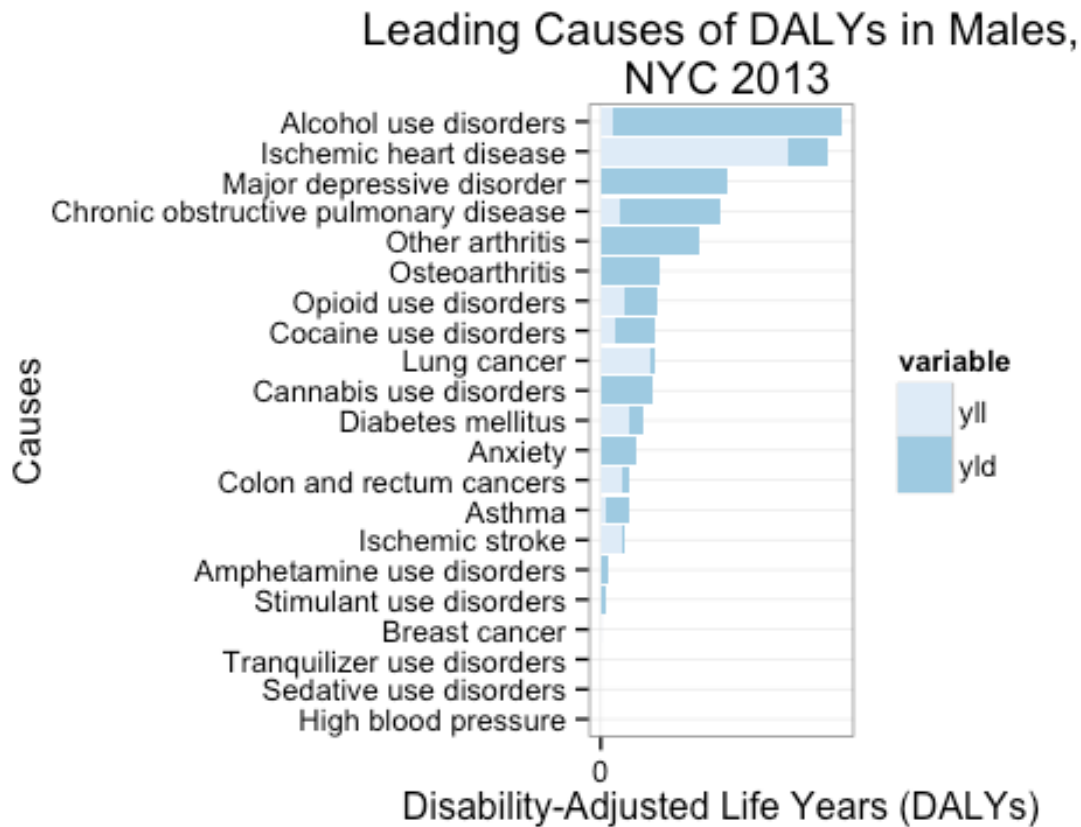
### 2013 NYC DALY Estimates, Male

cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Alcohol use disorders	Male	3694	72958	101127	49577	76651	104820	53271
Ischemic heart disease	Male	59171	13079	14947	10484	72250	74119	69655
Major depressive disorder	Male	NA	40352	54452	27533	40352	54452	27533
Chronic obstructive pulmonary disease	Male	5818	32495	45865	21833	38313	51683	27650
Other arthritis	Male	NA	31037	43288	20963	31037	43288	20963
Osteoarthritis	Male	62	18723	26114	12647	18785	26176	12708
Opioid use disorders	Male	7701	9980	12502	7146	17681	20203	14847
Cocaine use disorders	Male	4910	12568	18484	7855	17478	23394	12765
Lung cancer	Male	15351	1926	2692	1304	17277	18044	16655

Diabetes mellitus	Male	8870	4770	5724	3816	13640	14594	12686
Anxiety	Male	NA	11399	18238	6459	11399	18238	6459
Colon and rectum cancers	Male	7021	1835	2565	1242	8856	9586	8263
Asthma	Male	1464	7269	12115	4038	8733	13579	5502
Cannabis use disorders	Male	NA	8054	11138	5459	8054	11138	5459
Cannabis use disorders	Male	NA	8054	11138	5459	8054	11138	5459
Ischemic stroke	Male	6876	608	1071	318	7484	7947	7195
Amphetamine use disorders	Male	NA	2514	3740	1531	2514	3740	1531
Stimulant use disorders	Male	NA	1610	2394	980	1610	2394	980
Breast cancer	Male	100	0	0	0	100	100	100
High blood pressure	Male	NA	0	0	0	0	0	0
Sedative use disorders	Male	NA	0	0	0	0	0	0
Tranquilizer use disorders	Male	NA	0	0	0	0	0	0

## Leading Causes of DALYs in Manhattan NYC 2013





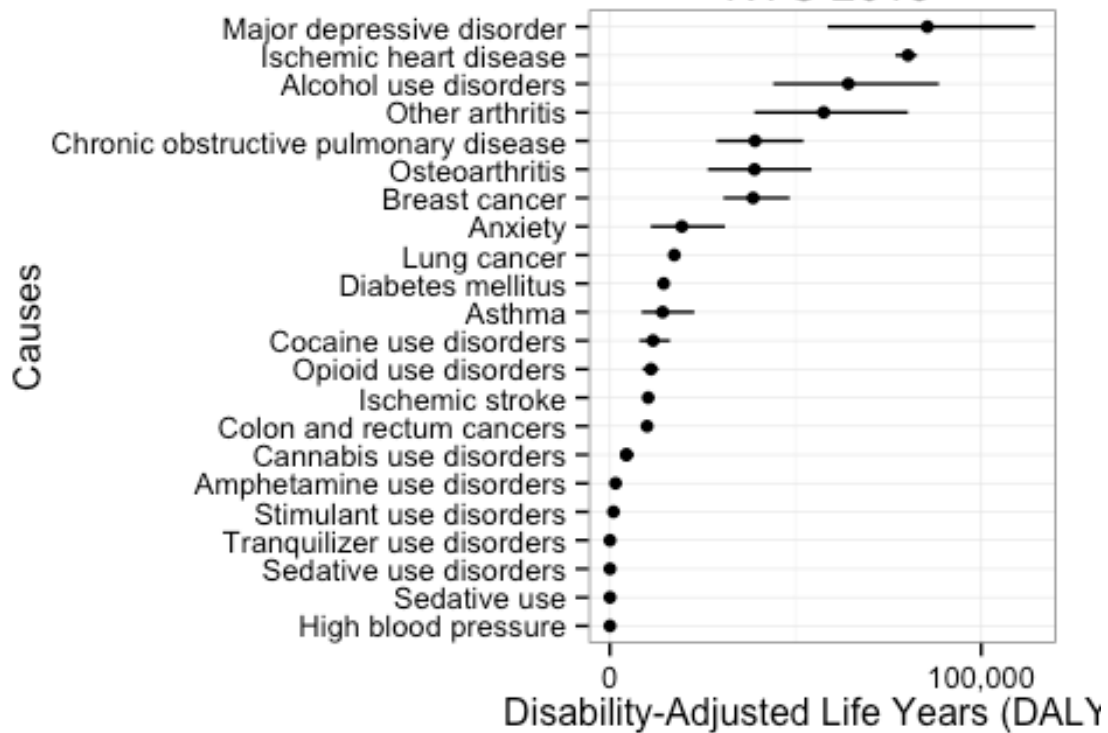
- Alcohol use disorders rises in proportion to major depressive disorder

### 2013 NYC DALY Estimates, Female

cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Major depressive disorder	Female	NA	85478	114432	58621	85478	114432	58621
Ischemic heart disease	Female	63155	17107	19551	13713	80262	82705	76867
Alcohol use disorders	Female	980	63206	87610	42951	64186	88590	43931
Other arthritis	Female	NA	57555	80274	38875	57555	80274	38875
Chronic obstructive pulmonary disease	Female	7306	31758	44824	21337	39063	52130	28643
Osteoarthritis	Female	67	38863	54204	26250	38931	54271	26317
Breast cancer	Female	13773	24769	34626	16765	38542	48399	30539
Anxiety	Female	NA	19353	30965	10967	19353	30965	10967

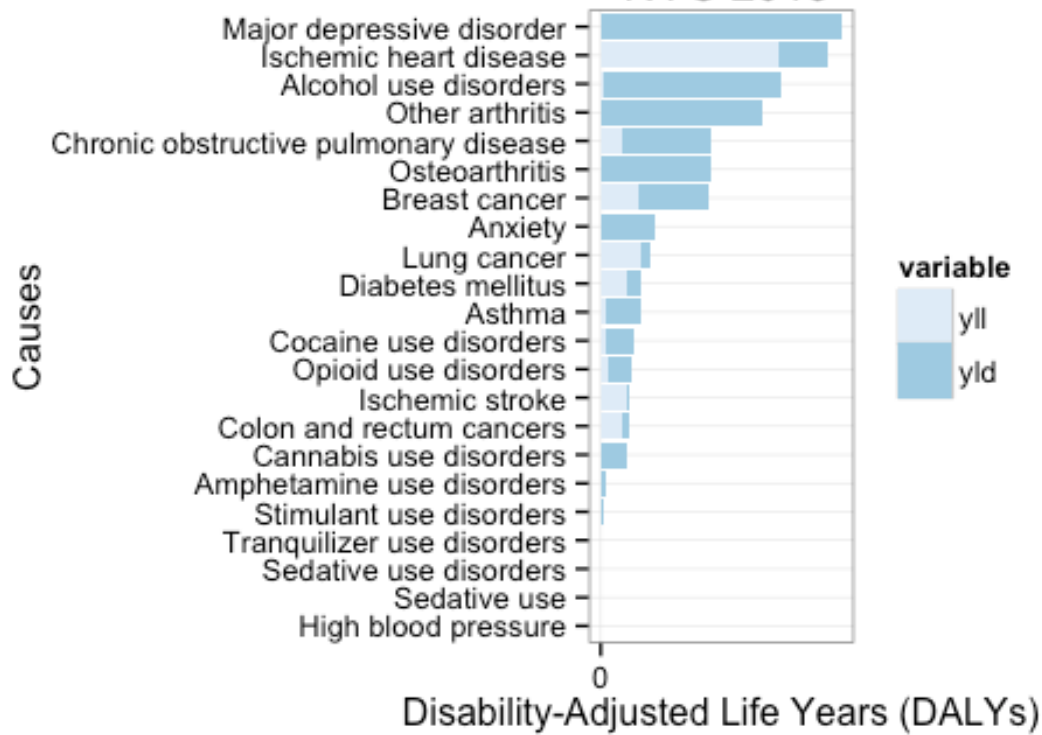
Lung cancer	Female	14313	3011	4210	2038	17324	18523	16351
Diabetes mellitus	Female	9114	5349	6419	4279	14464	15533	13394
Asthma	Female	1399	12789	21315	7105	14189	22715	8505
Cocaine use disorders	Female	1828	9765	14361	6103	11593	16189	7931
Opioid use disorders	Female	2953	8090	10134	5793	11042	13087	8745
Ischemic stroke	Female	9081	1212	2136	635	10294	11217	9716
Colon and rectum cancers	Female	7362	2636	3685	1784	9998	11047	9146
Cannabis use disorders	Female	NA	4442	6142	3010	4442	6142	3010
Cannabis use disorders	Female	NA	4442	6142	3010	4442	6142	3010
Amphetamine use disorders	Female	NA	1510	2246	920	1510	2246	920
Stimulant use disorders	Female	NA	939	1396	572	939	1396	572
High blood pressure	Female	NA	0	0	0	0	0	0
Sedative use	Female	NA	0	0	0	0	0	0
Sedative use disorders	Female	NA	0	0	0	0	0	0
Tranquilizer use disorders	Female	NA	0	0	0	0	0	0

## Leading Causes of DALYs in Fer NYC 2013



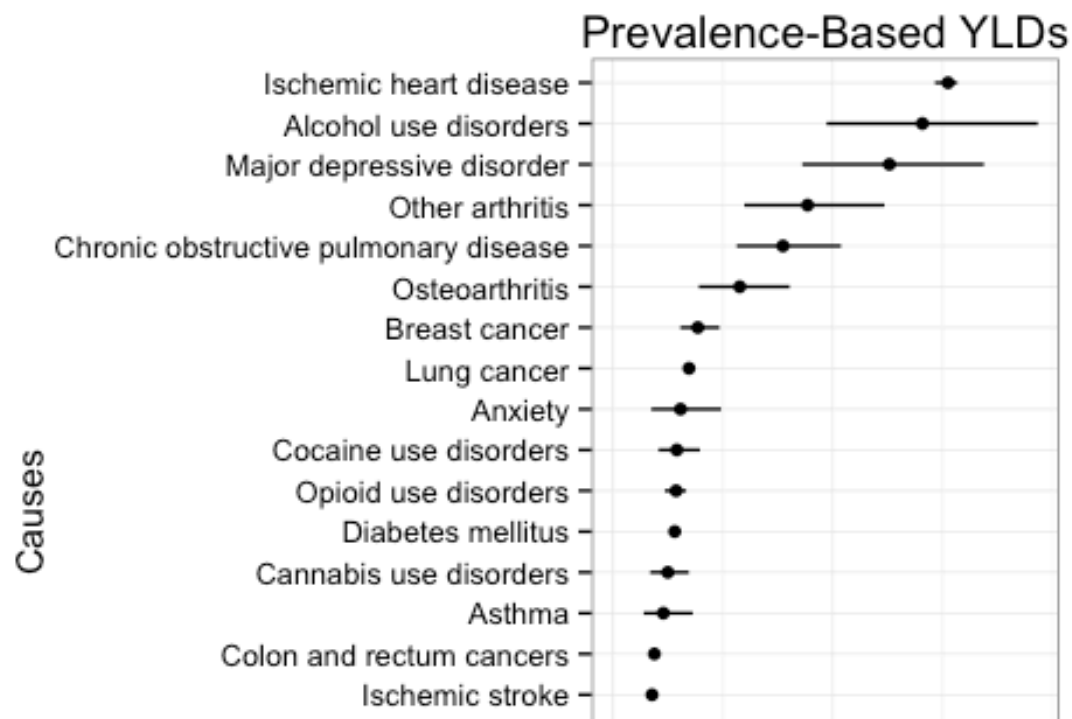
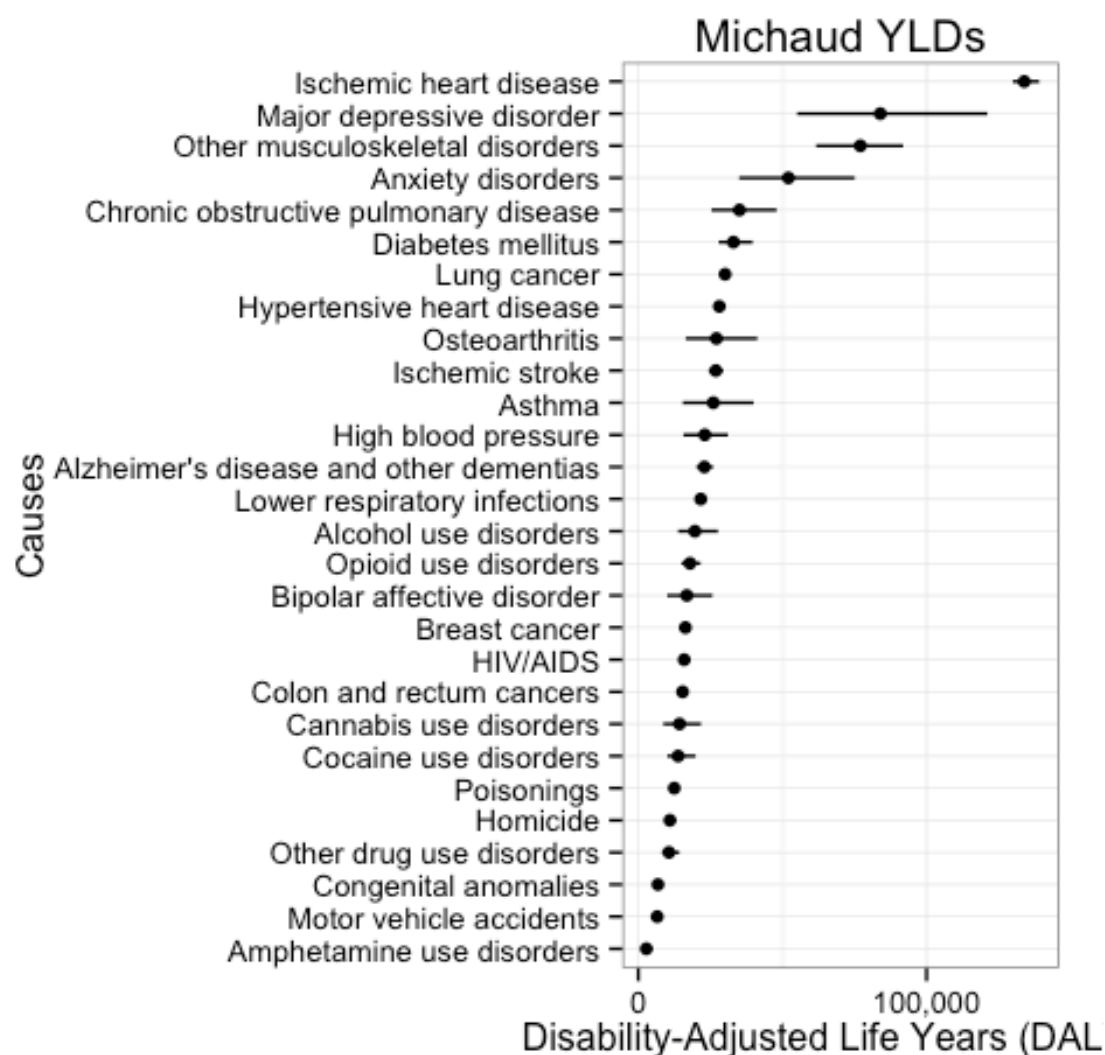


## Leading Causes of DALYs in Females, NYC 2013

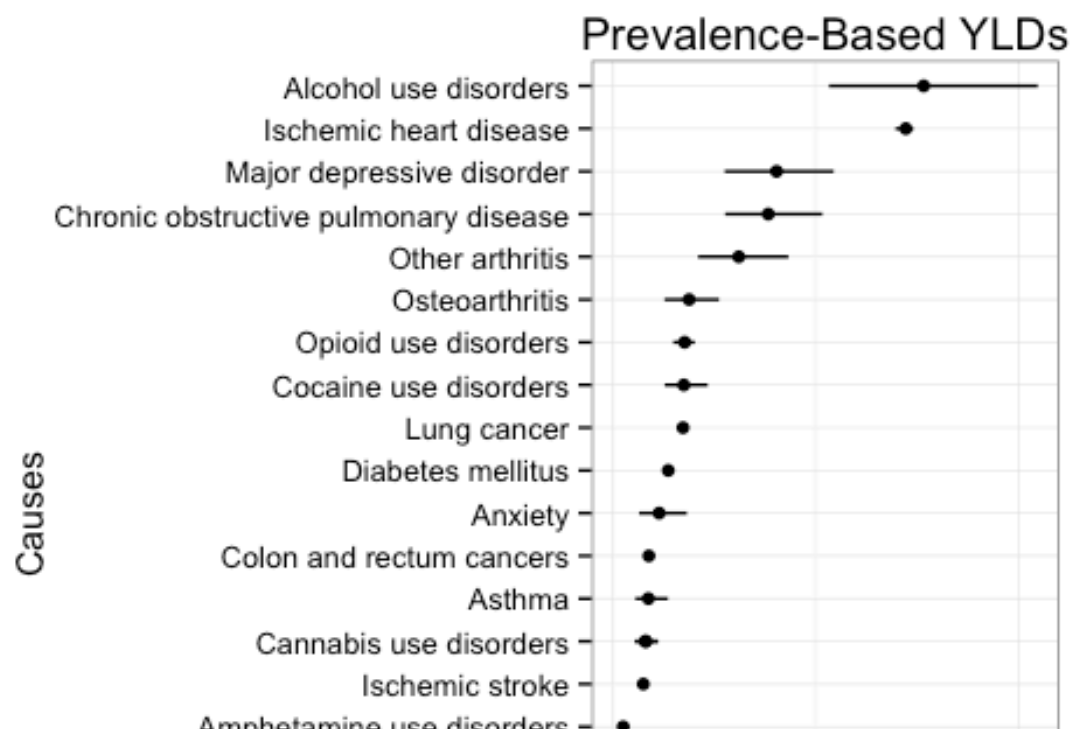
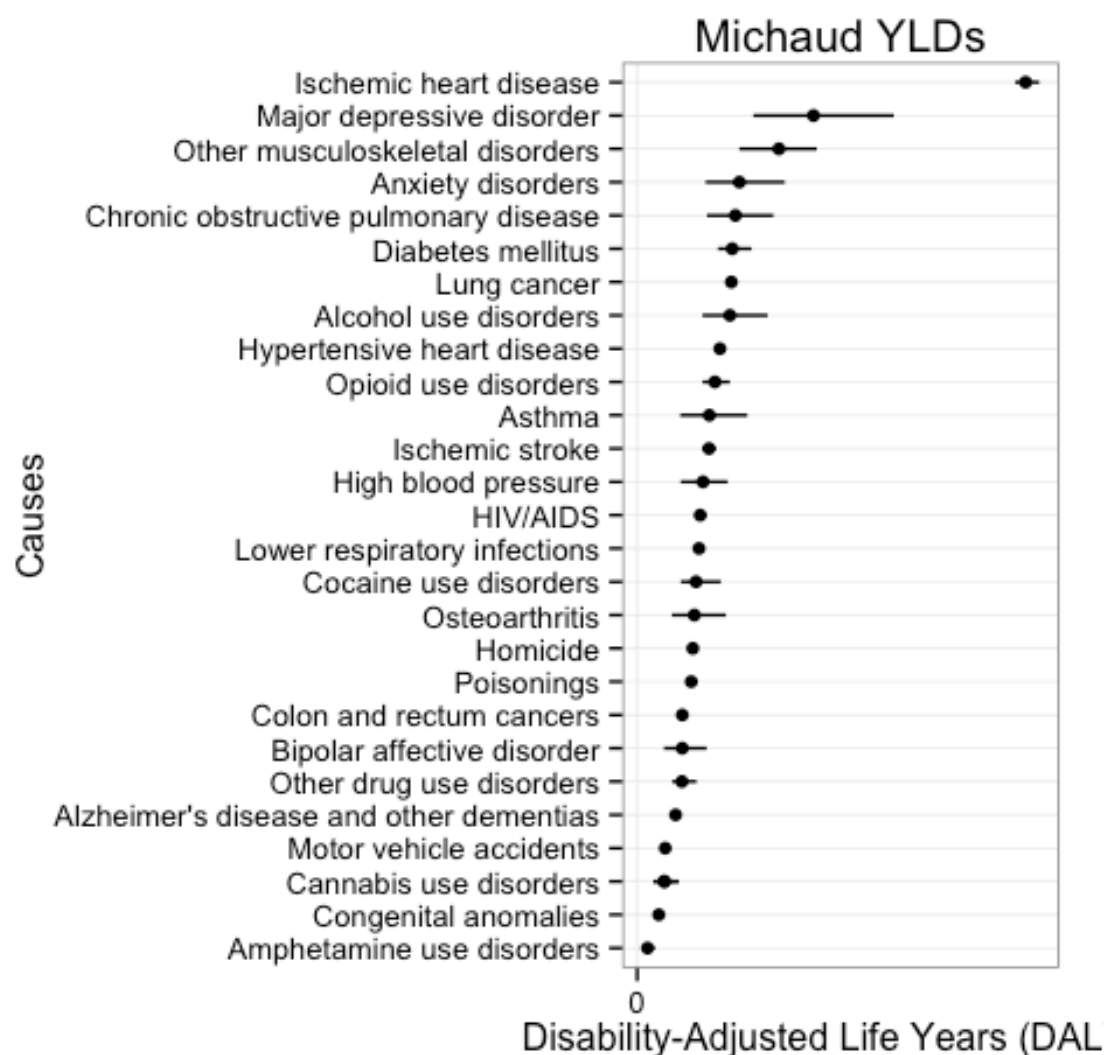


**Michaud YLDs vs. Prevalence-Based YLDs: Side-by-Side Comparison**

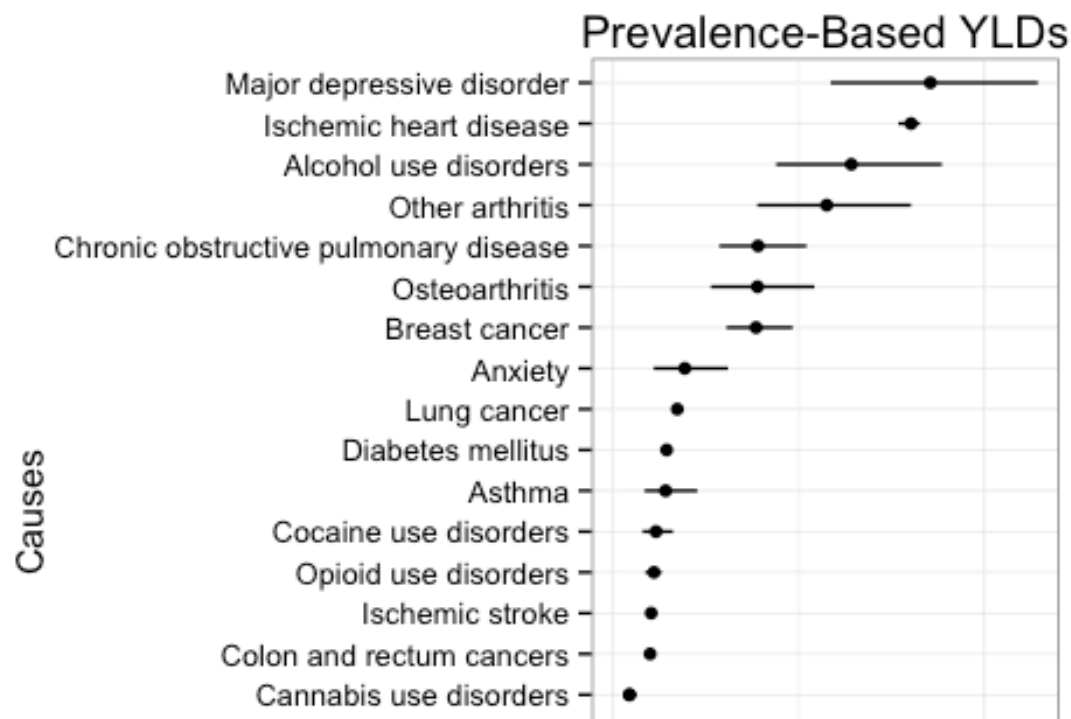
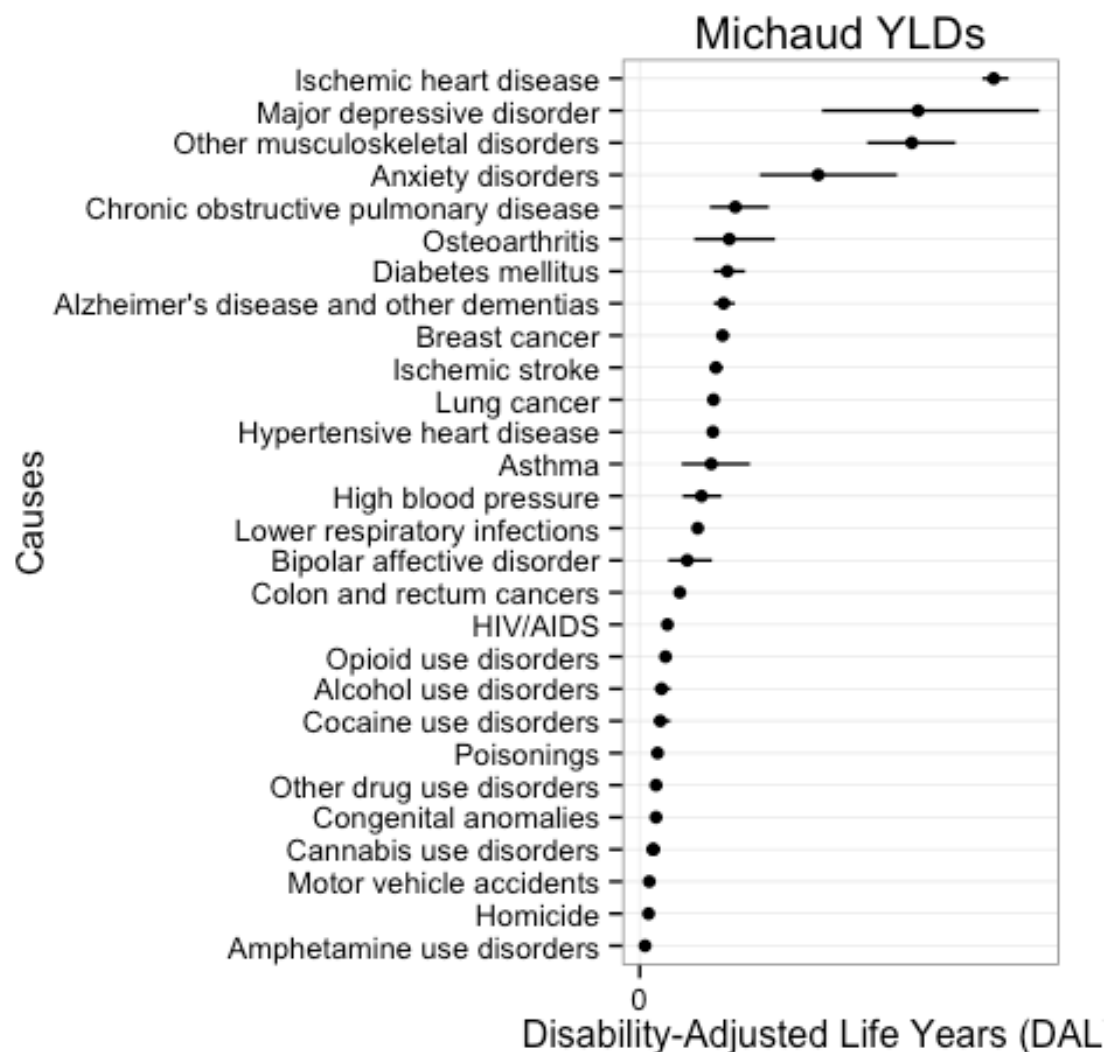
**Total**



**Male**



**Female**



## Disease Conditions with Small Sample Sizes

##	cause_name	seqlae	sex	age
## 25	Breast cancer	Breast cancer	Male	20-39
## 26	Breast cancer	Breast cancer	Male	40-59
## 27	Breast cancer	Breast cancer	Male	60+
## 28	Breast cancer	Breast cancer	Female	20-39
## 36	Cocaine use disorders	Cocaine use	Female	60+
## 37	Colon and rectum cancers	Colon and rectum cancers	Male	20-39
## 38	Colon and rectum cancers	Colon and rectum cancers	Male	40-59
## 39	Colon and rectum cancers	Colon and rectum cancers	Male	60+
## 40	Colon and rectum cancers	Colon and rectum cancers	Female	20-39
## 41	Colon and rectum cancers	Colon and rectum cancers	Female	40-59
## 42	Colon and rectum cancers	Colon and rectum cancers	Female	60+
## 55	Opioid use disorders	Heroin use	Male	20-39
## 56	Opioid use disorders	Heroin use	Male	40-59
## 57	Opioid use disorders	Heroin use	Male	60+
## 58	Opioid use disorders	Heroin use	Female	20-39
## 59	Opioid use disorders	Heroin use	Female	40-59
## 60	Opioid use disorders	Heroin use	Female	60+
## 67	Ischemic heart disease	Ischemic heart disease	Male	20-39
## 70	Ischemic heart disease	Ischemic heart disease	Female	20-39
## 73	Lung cancer	Lung	Male	20-39
## 74	Lung cancer	Lung	Male	40-59
## 75	Lung cancer	Lung	Male	60+
## 76	Lung cancer	Lung	Female	20-39
## 77	Lung cancer	Lung	Female	40-59
## 78	Lung cancer	Lung	Female	60+
## 87	Amphetamine use disorders	Methamphetamine use	Male	20-39
## 88	Amphetamine use disorders	Methamphetamine use	Male	40-59
## 89	Amphetamine use disorders	Methamphetamine use	Male	60+
## 90	Amphetamine use disorders	Methamphetamine use	Female	20-39
## 91	Amphetamine use disorders	Methamphetamine use	Female	40-59
## 92	Amphetamine use disorders	Methamphetamine use	Female	60+
## 101	Major depressive disorder	moderate depression	Male	60+
## 105	Major depressive disorder	moderately severe depression	Male	20-39
## 106	Major depressive disorder	moderately severe depression	Male	40-59
## 107	Major depressive disorder	moderately severe depression	Male	60+
## 111	Other arthritis	Other arthritis	Male	20-39
## 125	Major depressive disorder	severe depression	Male	20-39
## 126	Major depressive disorder	severe depression	Male	40-59
## 127	Major depressive disorder	severe depression	Male	60+
## 128	Major depressive disorder	severe depression	Female	20-39
## 130	Major depressive disorder	severe depression	Female	60+
## 139	Ischemic stroke	Ischemic stroke	Male	20-39
## 140	Ischemic stroke	Ischemic stroke	Male	40-59
## 141	Ischemic stroke	Ischemic stroke	Male	60+
## 142	Ischemic stroke	Ischemic stroke	Female	20-39



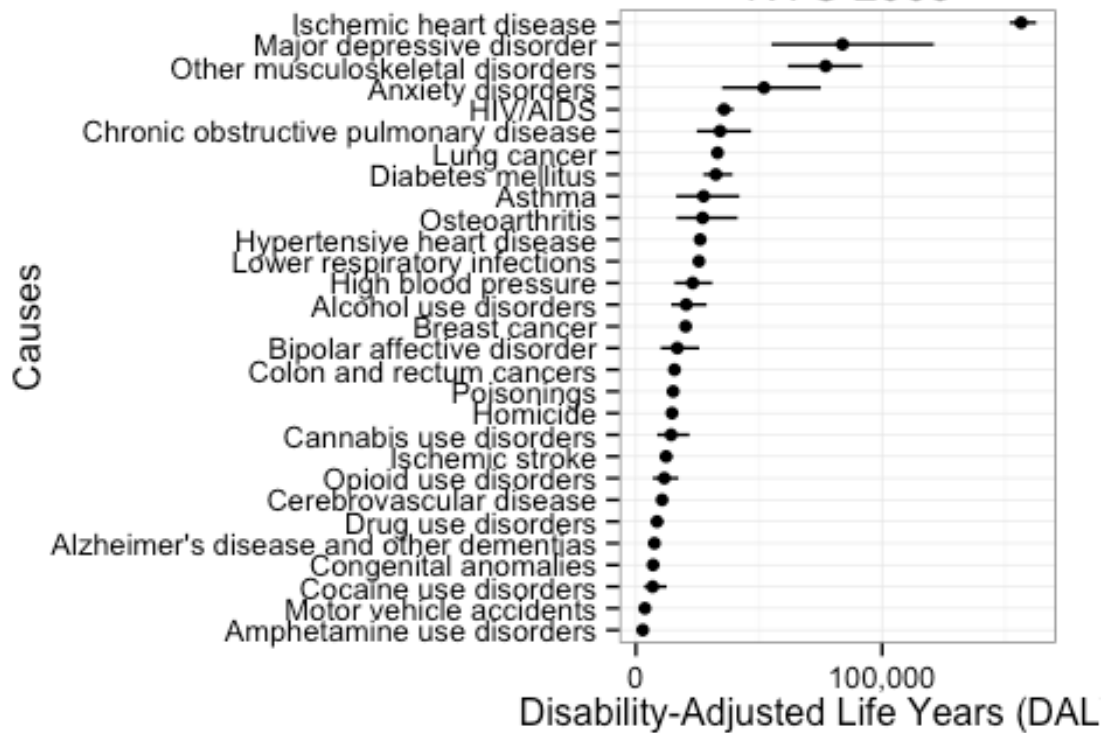
## Sensitivity Analysis

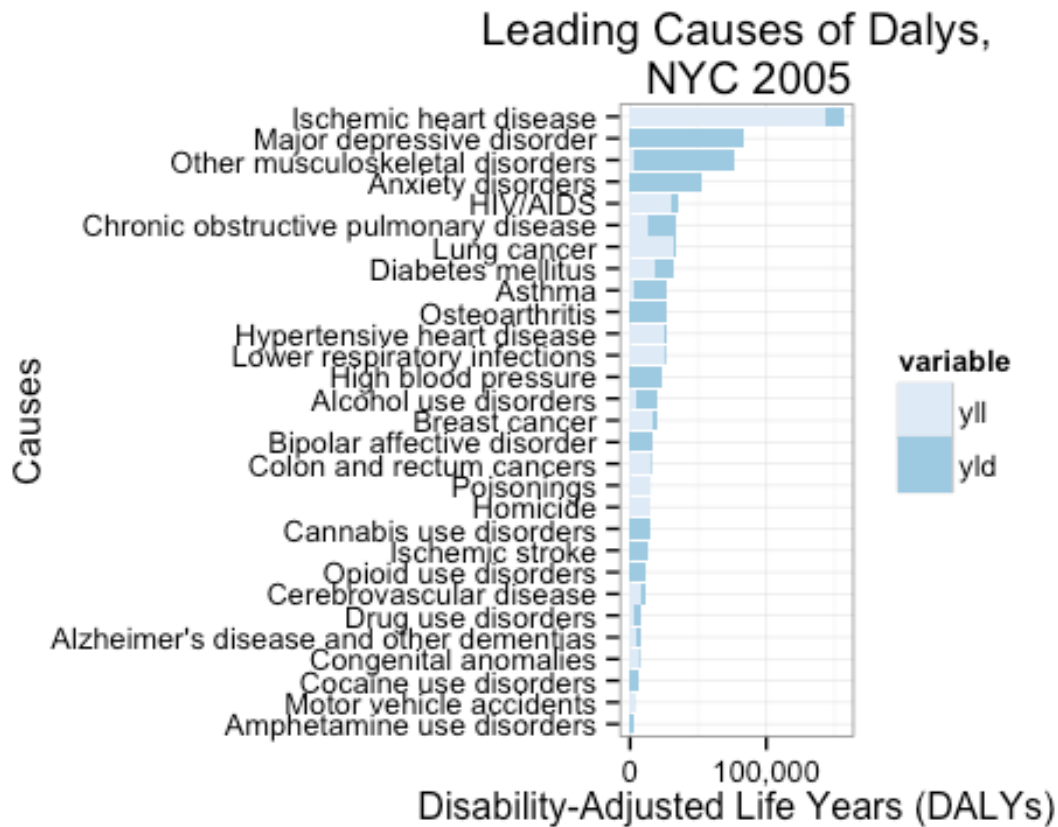
### 2005 NYC DALY Estimates, Total

cause_name	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	142893	13658	19810	8966	156550	162703	151859
Major depressive disorder	0	83953	121100	55076	83953	121100	55076
Other musculoskeletal disorders	2885	74223	89073	58852	77108	91957	61737
Anxiety disorders	0	52051	75105	34951	52051	75105	34951
HIV/AIDS	29554	6239	10198	3244	35793	39752	32798
Chronic obstructive pulmonary disease	12759	21453	34059	11961	34212	46818	24720
Lung cancer	32684	485	883	225	33169	33567	32909
Diabetes mellitus	17422	15059	21862	9929	32481	39284	27351
Asthma	3187	24307	38885	13140	27494	42073	16327
Osteoarthritis	149	26968	41201	16316	27117	41350	16465
Hypertensive heart disease	25274	835	1519	384	26108	26792	25658
Lower respiratory infections	24303	1312	1981	809	25615	26284	25112
High blood pressure	0	23051	31082	15615	23051	31082	15615
Alcohol use disorders	4921	15510	23839	9449	20431	28761	14370
Breast cancer	17147	3054	4732	1956	20201	21880	19103
Bipolar affective disorder	0	16820	25727	10012	16820	25727	10012
Colon and rectum cancers	14606	1055	1774	618	15661	16380	15224
Poisonings	15023	88	230	13	15111	15253	15036
Homicide	14663	NA	NA	NA	14663	NA	NA
Cannabis use disorders	0	14303	21780	8642	14303	21780	8642
Ischemic stroke	0	12250	14808	9752	12250	14808	9752
Opioid use disorders	0	11530	17272	6864	11530	17272	6864
Cerebrovascular disease	8046	2585	3094	2076	10630	11139	10122
Drug use disorders	2326	6231	8780	4202	8557	11106	6528
Alzheimer's disease and other dementias	4452	3053	4060	2154	7505	8512	6606
Congenital anomalies	5859	1111	1741	672	6971	7600	6531

Cocaine use disorders	0	6792	12484	3277	6792	12484	3277
Motor vehicle accidents	3135	512	775	325	3647	3910	3460
Amphetamine use disorders	0	2773	4845	1347	2773	4845	1347

## Leading Causes of Dalys, NYC 2005



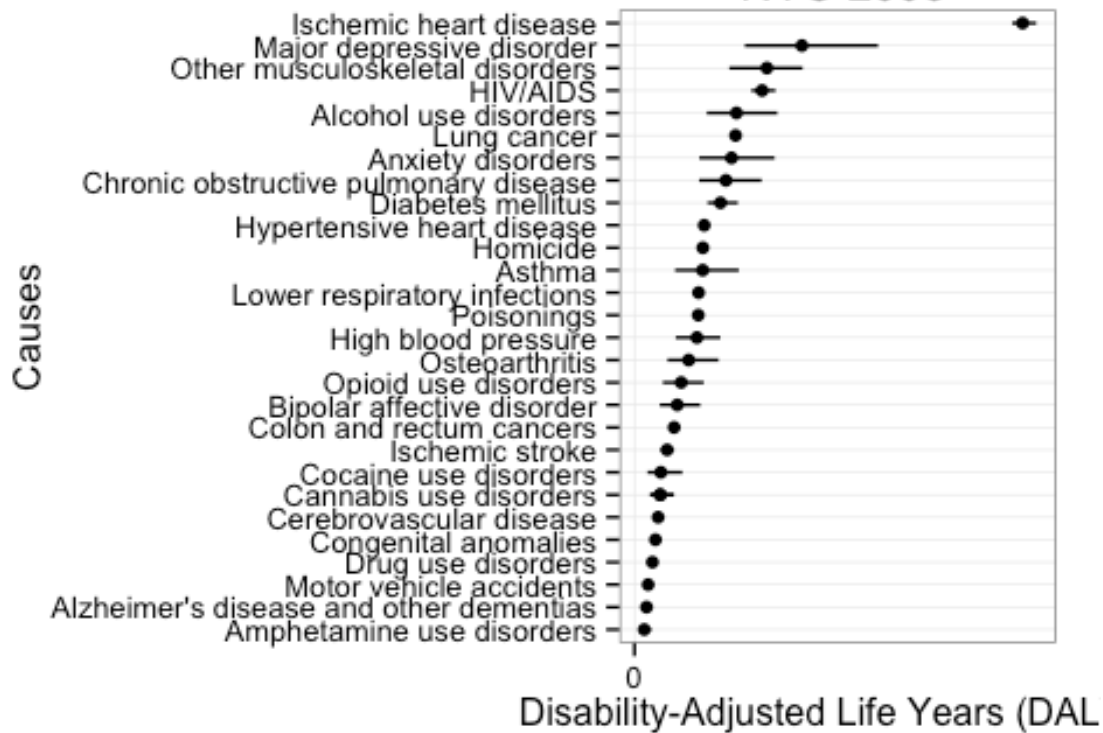


### 2005 NYC DALY Estimates, Male

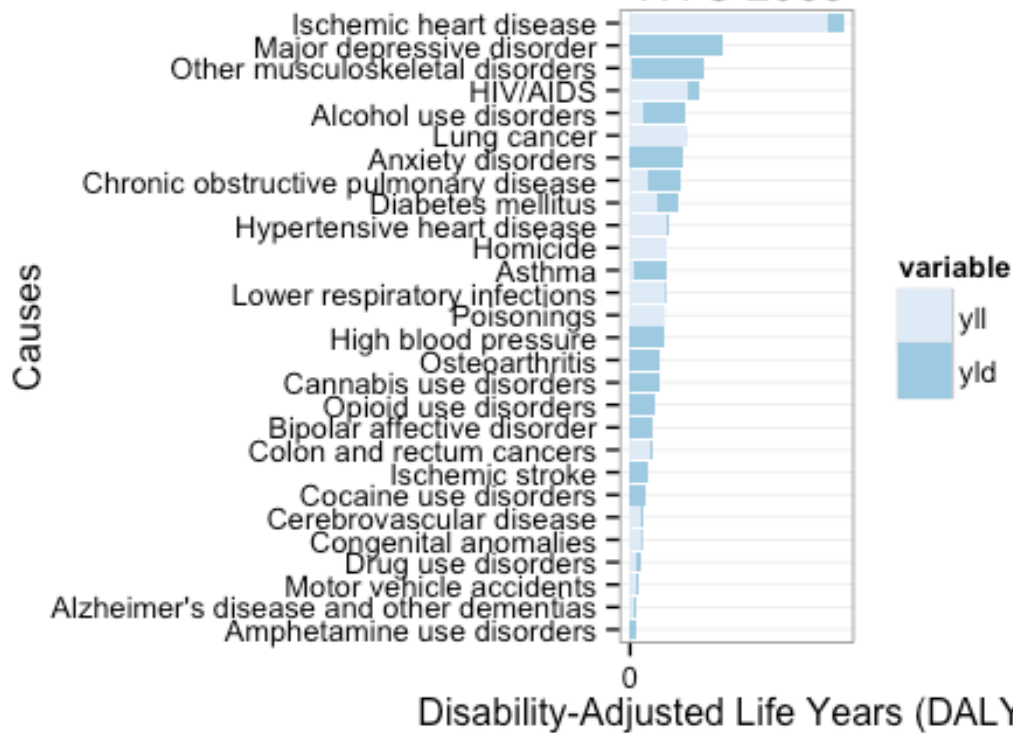
cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	Male	62241	5253	7628	3433	67494	69869	65674
Major depressive disorder	Male	0	29122	42380	19172	29122	42380	19172
Other musculoskeletal disorders	Male	604	22433	28657	15884	23036	29261	16487
HIV/AIDS	Male	17948	4244	6583	2371	22192	24532	20319
Alcohol use disorders	Male	4438	13308	20434	8139	17747	24873	12577
Lung cancer	Male	17348	238	411	121	17586	17759	17469
Anxiety disorders	Male	0	16888	24380	11291	16888	24380	11291
Chronic obstructive pulmonary disease	Male	5605	10302	16528	5655	15907	22133	11260
Diabetes mellitus	Male	8440	6526	9561	4265	14967	18002	12705

Hypertensive heart disease	Male	11866	268	491	120	12134	12357	11986
Homicide	Male	11903	NA	NA	NA	11903	NA	NA
Asthma	Male	1409	10463	16739	5641	11871	18148	7050
Lower respiratory infections	Male	10657	513	786	311	11170	11443	10968
Poisonings	Male	11035	70	176	12	11105	11210	11047
High blood pressure	Male	0	10872	14946	7183	10872	14946	7183
Osteoarthritis	Male	59	9384	14597	5661	9443	14656	5720
Opioid use disorders	Male	0	8139	12049	4928	8139	12049	4928
Bipolar affective disorder	Male	0	7449	11473	4414	7449	11473	4414
Colon and rectum cancers	Male	6478	421	680	250	6899	7158	6728
Ischemic stroke	Male	0	5693	6885	4521	5693	6885	4521
Cocaine use disorders	Male	0	4601	8347	2259	4601	8347	2259
Cannabis use disorders	Male	0	4486	6858	2705	4486	6858	2705
Cannabis use disorders	Male	0	4486	6858	2705	4486	6858	2705
Cerebrovascular disease	Male	3085	1042	1250	834	4126	4334	3918
Congenital anomalies	Male	3108	550	855	333	3658	3963	3441
Drug use disorders	Male	1620	1512	2134	1006	3132	3755	2626
Motor vehicle accidents	Male	2060	323	489	206	2383	2549	2267
Alzheimer's disease and other dementias	Male	1280	832	1114	589	2112	2395	1869
Amphetamine use disorders	Male	0	1711	2950	839	1711	2950	839

## Leading Causes of DALYs in M NYC 2005



## Leading Causes of DALYs in Males, NYC 2005



### 2005 NYC DALY Estimates, Female

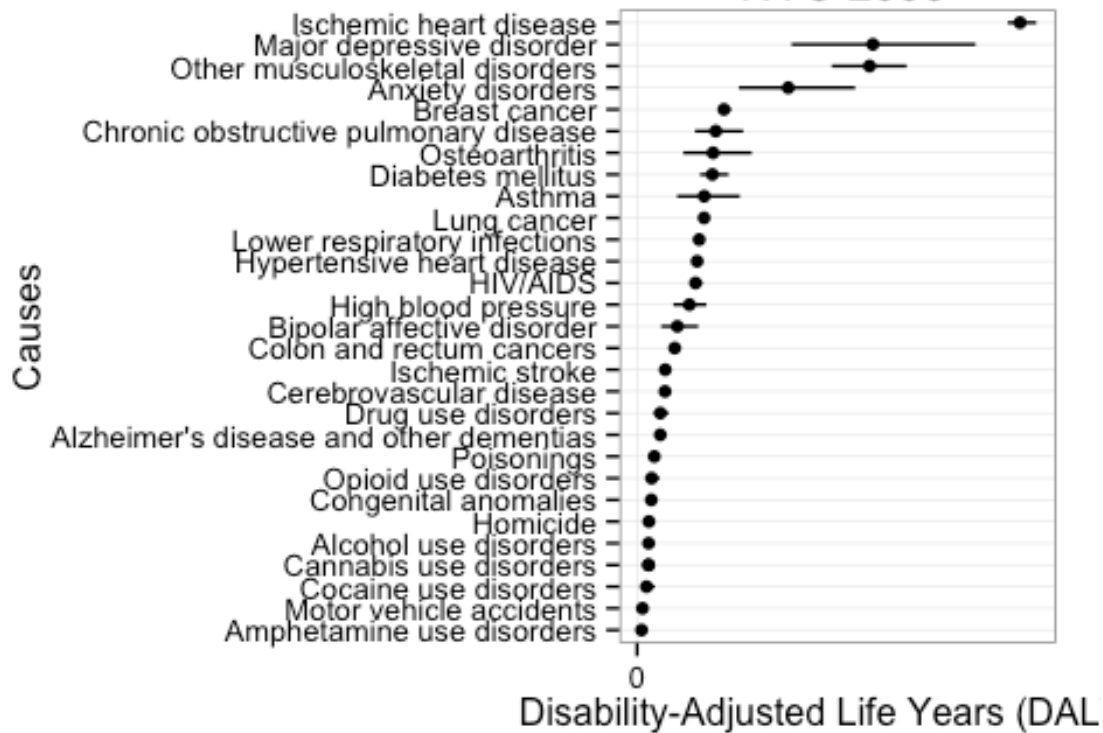
cause_name	sex	yll	yld	yld_upper	yld_lower	daly	daly_upper	daly_lower
Ischemic heart disease	Female	80652	8404	12182	5533	89056	92834	86184
Major depressive disorder	Female	0	54832	78719	35904	54832	78719	35904
Other musculoskeletal disorders	Female	2281	51790	60415	42969	54071	62696	45250
Anxiety disorders	Female	0	35163	50725	23660	35163	50725	23660
Breast cancer	Female	17147	3054	4732	1956	20201	21880	19103
Chronic obstructive pulmonary disease	Female	7154	11151	17530	6307	18305	24685	13461
Osteoarthritis	Female	90	17585	26605	10655	17674	26694	10745
Diabetes	Female	8982	8533	12301	5665	17514	21282	14646

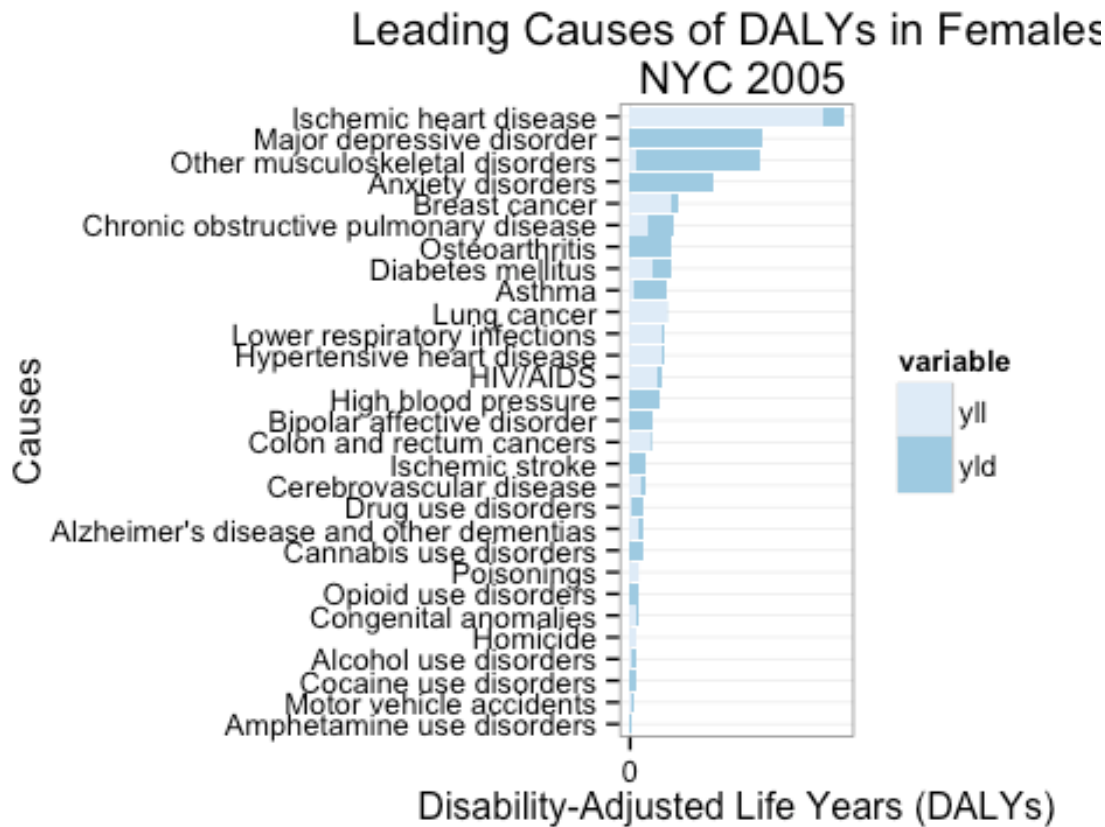
mellitus

Asthma	Female	1779	13844	22146	7499	15623	23925	9277
Lung cancer	Female	15336	247	472	104	15583	15808	15440
Lower respiratory infections	Female	13646	799	1196	498	14445	14841	14144
Hypertensive heart disease	Female	13407	567	1028	264	13974	14436	13671
HIV/AIDS	Female	11606	1995	3615	873	13601	15221	12479
High blood pressure	Female	0	12180	16136	8433	12180	16136	8433
Bipolar affective disorder	Female	0	9371	14254	5598	9371	14254	5598
Colon and rectum cancers	Female	8128	634	1095	368	8762	9223	8496
Ischemic stroke	Female	0	6556	7923	5231	6556	7923	5231
Cerebrovascular disease	Female	4961	1543	1844	1242	6504	6805	6203
Drug use disorders	Female	706	4719	6645	3197	5424	7351	3902
Alzheimer's disease and other dementias	Female	3172	2221	2946	1565	5393	6118	4737
Poisonings	Female	3988	18	54	1	4006	4042	3989
Opioid use disorders	Female	0	3390	5223	1936	3390	5223	1936
Congenital anomalies	Female	2751	562	886	339	3313	3637	3090
Homicide	Female	2760	NA	NA	NA	2760	NA	NA
Alcohol use disorders	Female	483	2202	3405	1310	2685	3888	1793
Cannabis use disorders	Female	0	2665	4032	1616	2665	4032	1616
Cannabis use disorders	Female	0	2665	4032	1616	2665	4032	1616
Cocaine use disorders	Female	0	2191	4138	1017	2191	4138	1017
Motor vehicle accidents	Female	1074	189	287	119	1264	1361	1193
Amphetamine use disorders	Female	0	1062	1895	508	1062	1895	508



## Leading Causes of DALYs in Fer NYC 2005





## Discussion

### Limitations

There are key limitations to this analysis. First and foremost, the magnitude of the DALY scores should be interpreted and reported with caution. Due to the small sample size of NYC prevalence estimates and the uncertainty around disability weights and national YLL/YLD rates for some conditions, DALY estimates can assume a wide range of values, changing how one condition ranks against the others (for example, alcohol use disorders and diabetes mellitus). For this reason, DALY magnitudes obtained via Michaud approach and the Prevalence-based YLDs cannot be directly compared.

Moreover, the accuracy of DALY estimations suffers from potential biases introduced in the data collection and computation processes. For example, comorbidities with respect to chronic diseases means that DALY estimates based on Vital Statistics mortality counts are overestimating the contribution of YLLs. Summation of prevalence YLDs across all causes can result in overestimation of the total average severity-weighted health state prevalence because of comorbidity between conditions (Mathers, 2006). Over-reporting of some conditions due to misclassification (e.g. where symptoms such as joint pain are labeled as osteoarthritis or occasional wheezing as asthma), under-reporting of undiagnosed conditions (e.g. most mental health problems), and lack of information on condition severity (resulting in high prevalences due to inclusion of very minor conditions or minor symptoms) may also contribute to biased DALY estimates.

In order to convey the uncertainty around our estimates, we visualize the range of values that NYC DALY estimates can take for each condition.

## Sensitivity Analysis

NYC DALY rankings and magnitudes using the Michaud approach are fairly consistent using both 2005 and 2013 NYC mortality counts. Moreover, the Michaud approach implemented in this analysis replicated the 2005 NYC DALY estimates from the previous NYC DOHMH study, producing comparable rankings. However, since age-weighting is no longer used due to ethical concerns, the 2013 NYC DALYs are slightly larger in magnitude. Recommendations for future work include running simulations to test the stability of DALY rankings for an even wider range of assumptions.

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## Economic Loss Estimates

### Methods

Within the major categories of conditions, cost data will be collected from literature reviews on the following variables:

- Lost productivity and leisure time
- Medical system costs
- Criminal justice system costs / social service costs

Cost estimates are limited by previous estimates published either in the medical literature and accessible on online databases (Google Scholar, PubMed) or from grey literature provided by the NYC DOHMH.

## **Selection**

Eligible studies will be identified using keywords in various combinations (e.g. “depression”, “economic costs”, “economic burden”, “caregiving costs”, “substance use”, “alcohol misuse”, “health care system costs”, “productivity loss” etc.). Searches are limited to English language, full-text articles focused specifically on New York City and/or the United States. Where possible, multiple studies will be reviewed.

## **Extraction**

Prevalence-based cost data estimates will be extracted and standardized by adjusting costs to 2014 dollars using the consumer price index and then applying a multiplier to reflect New York City costs. The cost per capita (per condition and variable) will be calculated by dividing the total cost estimate by the total population at-risk.

## Findings

Highlights of selected cost data on the major categories of conditions are presented below in Table 1 and summarized:

**Table 1 – Extracts of Cost Data Estimates**

All amounts in USD; per capita costs are in constant 2014 USD

Cost Variable	Major Depression	Alcohol Use	Illicit Drugs	Prescription Drug Misuse
<b>Lost productivity</b>				
Total cost estimate	63,000,000,000	161,286,100,000	120,304,004,000	42,029,230,000
Cost per capita	354.26	640.61	463.59	166.94
NY cost per capita	387.36	700.48	506.91	182.54
<b>Medical system</b>				
Total cost estimate	26,087,000,000	24,555,600,000	11,416,232,000	2,971,860,000
Cost per capita	128.11	97.53	43.99	11.80
NY cost per capita	140.08	106.65	48.10	12.91
<b>Criminal system</b>				
Total cost estimate	Undetermined	20,972,700,000	56,373,254,000	8,219,410,000
Cost per capita	Undetermined	83.30	217.23	32.65
NY cost per capita	Undetermined	91.09	237.53	35.70

## Major Depression

The per capita economic cost of lost productivity in New York City due to major depressive disorder is estimated at \$387.36, including lost productivity resulting from premature death, incarceration, and informal caregiving (The President's New Freedom Commission on Mental Health, 2003).

With lost productivity in the workplace, approximately 70% is attributable to absenteeism (i.e. days missed from work due to depression), and the remaining 30% to presenteeism (i.e. reduced productivity at work due to depression) (Greenberg et al., 2003).

Medical system costs per capita related to the treatment of depression is estimated at \$140.08, with direct costs including inpatient (34%), outpatient (26%), and pharmaceutical (40%) costs (Greenberg et al., 2003).

The criminal justice system and social service costs for depression are difficult to ascertain as a result of inadequate data.

## Alcohol Use

Economic costs of excessive alcohol consumption are extracted and adjusted from a study by Bouchery et al. (2011). Lost productivity per capita in New York City due to alcohol use disorder is estimated at \$700.48, including economic costs for premature mortality, impaired productivity, work absenteeism, crime, and health conditions such as fetal alcohol syndrome.

Presenteeism accounts for 46% of total lost productivity at cost per capita of \$321.83. A further breakdown indicates that binge drinking drives 68% of impaired productivity at work.

Medical system costs per capita of \$106.65 for alcohol use disorder includes special treatment for alcohol dependence and abuse, treatment costs for health conditions such as fetal alcohol syndrome, hospitalizations, and health insurance administration costs, among others. Costs arising from binge drinking have a large impact on health care costs overall.

The per capita cost of alcohol-attributable crime is \$91.09, including costs for policing (21%), legal and adjudication (18%), correctional institutions (60%), and others.

## **Illicit Drug Use**

Illicit drugs included in the scope of the report issued by the U.S. Department of Justice National Drug Intelligence Center (2011) are Schedule I drugs (heroin and marijuana) and Schedule II-IV drugs (cocaine, methamphetamine, tranquilizers, stimulants, and sedatives).

Productivity lost to illicit drug use in New York City amounts to a cost per capita of \$506.91 in the context of labor participation, specialty drug treatment, hospitalization, incarceration, and premature mortality. Two factors – reduced labor participation and being incarcerated due to illicit drug use – reflect 81% of total productivity losses.

The estimated medical system cost per capita from illicit drug use is \$48.10. Treatment in specialty centers (\$15.60) and hospital emergency departments (\$24.01) account for 83% of health care costs incurred.

Criminal justice system costs include police protection, adjudication, and corrections expenditures, which are estimated at \$237.53 per capita.

## **Non-Medical Use of Prescription Opioids**

The economic burden of the non-medical use of prescription opioids in New York City was estimated using cost data from a study by Hansen et al. (2010).

Lost productivity cost per capita is \$182.54, with costs included for the impact of the non-medical use of prescription opioids on mortality, unemployment and subemployment, and incarceration.

Medical system cost per capita is \$12.91, of which treatment at substance abuse facilities (\$4.87) is the largest cost component.

The per capita cost of the criminal justice system is \$35.70. The estimate is based on the costs of police services, the legal system, and incarceration.

## **Discussion**

Lost productivity is consistently the highest economic burden across the major categories of major depression, alcohol use disorder, illicit drug use, and the non-medical use of prescription opioids. Criminal justice system costs are higher than medical system costs in most instances, although other

indirect costs (aside from productivity losses) such as reduced quality of life are not included due to a lack of data.

As previously noted, the literature review is limited by the sparse data on cost estimates of productivity, health, and crime, as they relate to the major categories of conditions. As well, differences in cost definitions and calculation methodology limit our ability to make direct comparisons of cost variables across the major conditions. Combined with the lack of cost data available, it is also not possible to assess cost variables together from different studies on the same condition.

However, the literature review suggests that the economic costs of productivity, health, and crime associated with the major categories of conditions are substantial, highlighting the importance of investment in prevention and treatment interventions in New York City.

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