NHANES_FPED_EDA

April 6, 2021

Objectives

Perform more exploratory analysis on the input data for the logistic regression model. The goal is to come up with data filters and transformations that can be used to address assumptions about the research question. The model can then be re-evaulated and compared to the intial prediction rate results.

Re-evaluate model with different techniques for constraining the observation space:

Use subsets of meals within calorie distribution categories. For example: is there any difference between low calories and high calorie meals?

Explore the possibility of transforming the input data from continuous to categorical.The component variables contain a high amount of 0's with a right tail heavy distribution.

Use only meals that are consumed at home, since eating out is generally more unhealthy

Constrain the non-seafood class to meals containing meat only. This will exclude vegetarian meals and compare seafood consumers to meat consumers.

Use a participant age filter, to look for adult participants only.

Attempt a classification of meals that contain both meat and seafood.

Convert input variables to standard units (some are in grams, some are in cups, etc.)

Input from research collaborators:

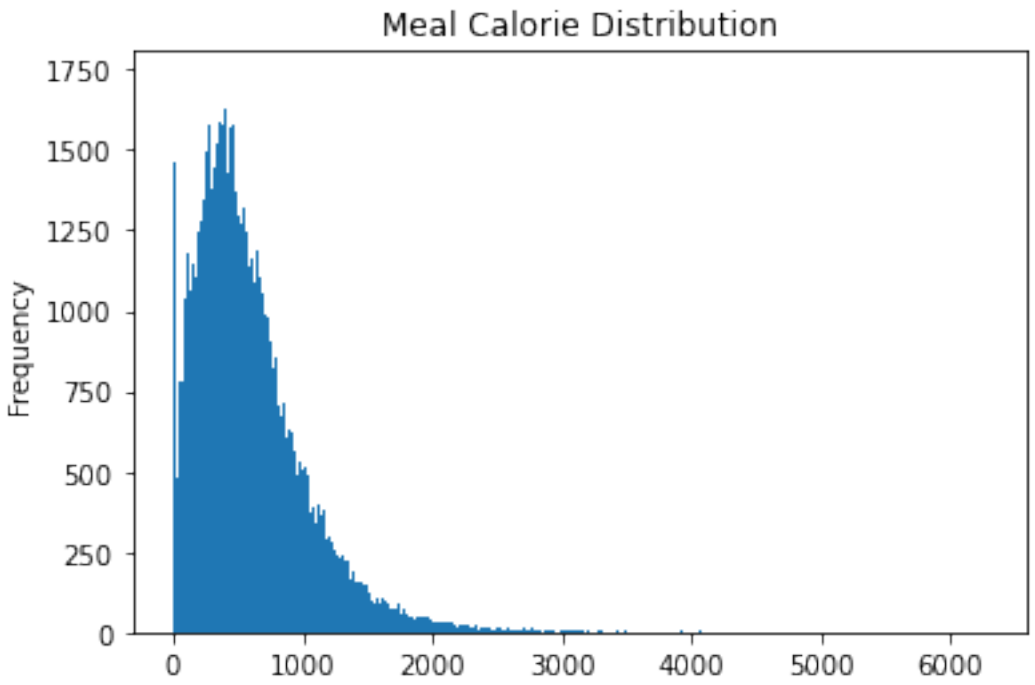
```
Obtain a more educated selection of input variables.
```

```
Attempt to weight the observations, to adjust for the survey design methods.
```

Section 1: Meal Energy Statistics

[98]:
```
import pandas as pd

#Read data frame and add plant pf total variable
df = pd.read_csv('../../Data/nhanes_full_pre_proc.csv')
df['PF_PLANT_D_TOTAL'] =␣
↪df['PF_EGGS']+df['PF_SOY']+df['PF_NUTSDS']+df['PF_LEGUMES']

df['DR1IKCAL'].plot.hist(bins=500, title='Meal Calorie Distribution')
```

[98]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5b4d86fd0>
```



The plot above is displaying the distribution of the KCAL variable. One apparent potential issue is the left most bar, indicating meals where this variable is equal to 0.

[64]:
```
zero_kcal_meals = df[df['DR1IKCAL']==0]
len(zero_kcal_meals)
```

[64]: 981

Indeed, there are 981 meals where KCAL = 0.

[65]:
```
zero_kcal_meals[['SEQN', 'DR1.030Z', 'DR1.020', 'DR1IKCAL']].head(5)
```

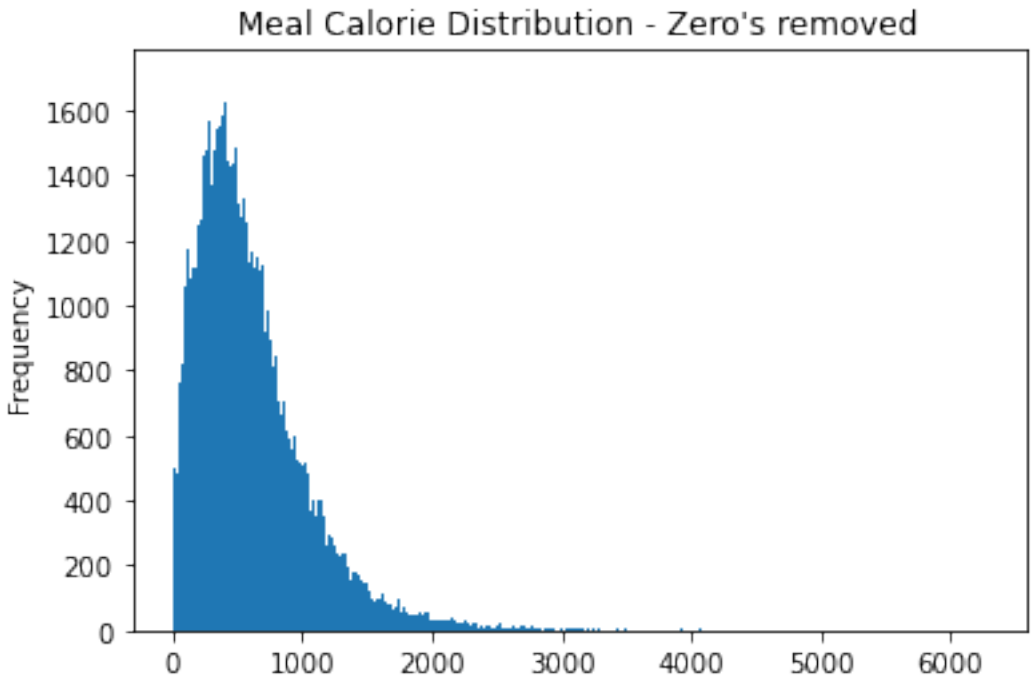
[65]:

	SEQN	DR1.030Z	DR1.020	DR1IKCAL
361	31330	3	90000	0.0
413	31364	14	86400	0.0
489	31411	15	54000	0.0
490	31411	15	70200	0.0
491	31411	15	75600	0.0

Table: Sample of users with meals that are 0 KCAL, for further investigation.

[90]:
```
#Filter out 0 KCAL meals
df = df[df['DR1IKCAL'] > 0]
df['DR1IKCAL'].plot.hist(bins=500, title='Meal Calorie Distribution - Zero\'s␣
↪removed')
```

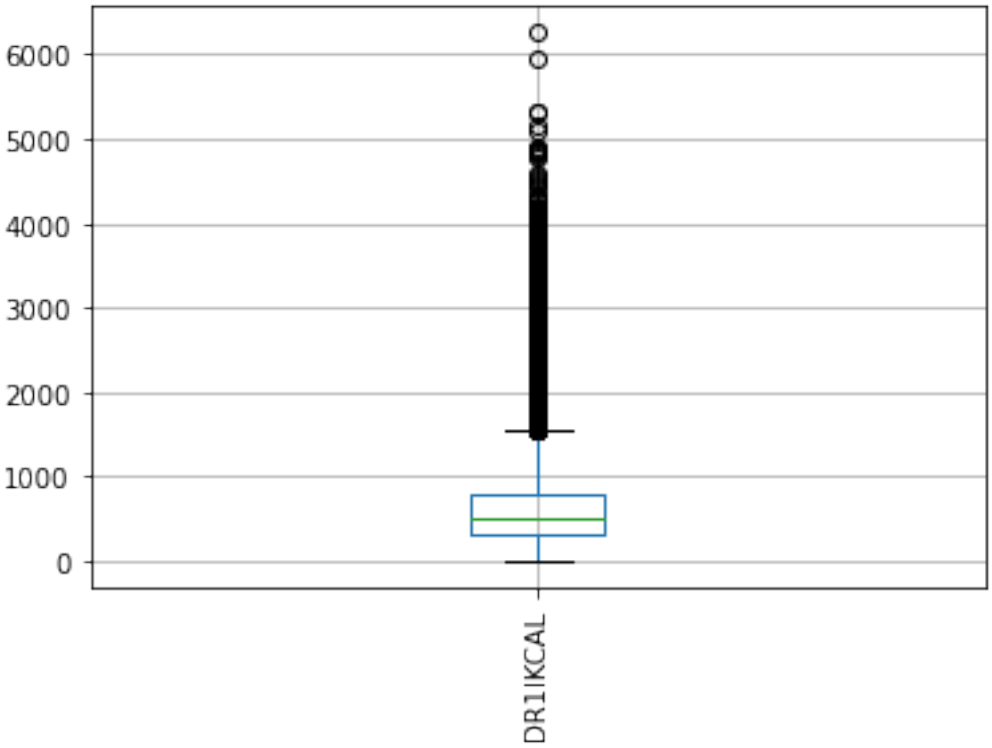
[90]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe5b06dc4f0>



Plot: Meal calories distribution with meals that are 0 KCAL removed.

[93]:
```
df.boxplot(column='DR1IKCAL',rot=90)
```

[93]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe5b23671f0>



Plot: Boxplot of meal calories distribution with meals that are 0 KCAL removed.

[67]:
```
#Obtain statistics for KCAL
df['DR1IKCAL'].describe()
```

[67]:
```
count    101731.000000
mean        605.018942
std         445.749113
min           1.000000
25%         297.000000
50%         508.000000
75%         798.000000
max        6264.000000
Name: DR1IKCAL, dtype: float64
```

Table: Statistical distribution of the KCAL variable, with 0 KCAL meals removed.

[68]:
```
#Home vs Out Meals
df.groupby('eathome')['DR1IKCAL'].describe()
```

[68]:

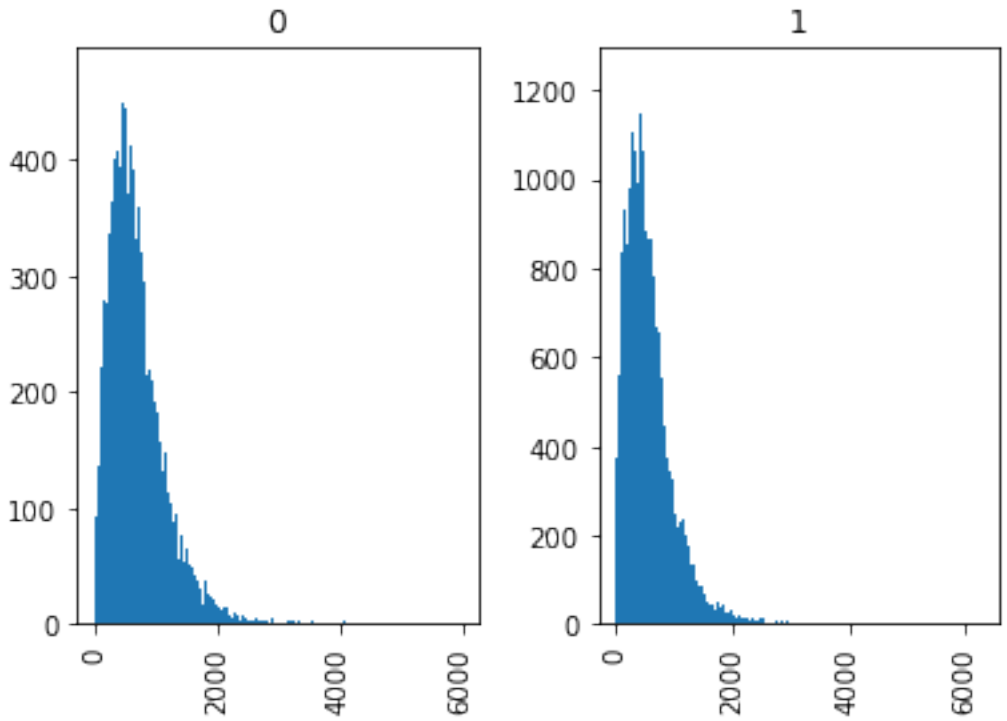
eathome	count	mean	std	min	25%	50%	75%	max
0	32830.0	687.545111	476.684325	1.0	360.0	587.0	899.0	5957.0

```
1        68901.0  565.696811  424.626035  1.0  271.0  471.0  751.0  6264.0
```

Table: Statistical distribution of the KCAL variable within the 'eathome' groups, with 0 KCAL meals removed.

[96]:
```
#Home vs Out Meals
df['DR1IKCAL'].hist(bins=500, by=df['eathome'])
```

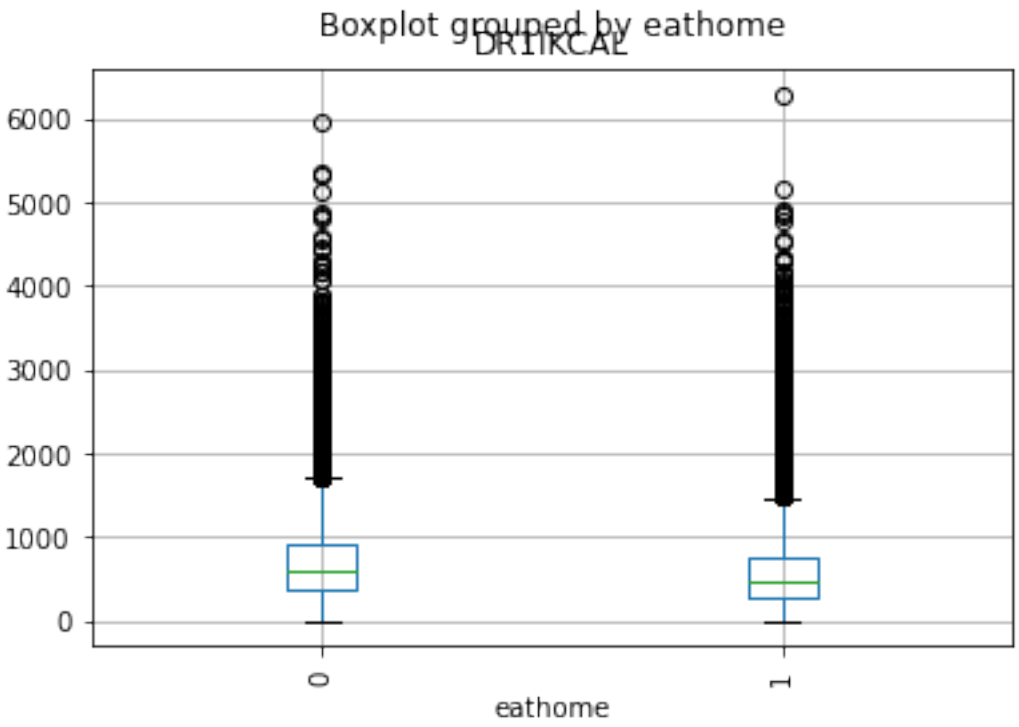
[96]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x7fe5b4d5aa00>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x7fe5b4e04460>],
      dtype=object)
```



Plot: Meal calories distribution with meals that are 0 KCAL removed, split by 'eathome' groups.

[84]:
```
df.boxplot(column='DR1IKCAL',by='eathome',rot=90)
```

[84]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5d013caf0>
```



Plot: Boxplot of meal calories distribution with meals that are 0 KCAL removed, split by 'eathome' groups.

[70]:
```
#Seafood vs non seafood meals
df.groupby('seafood_meal')['DR1IKCAL'].describe()
```

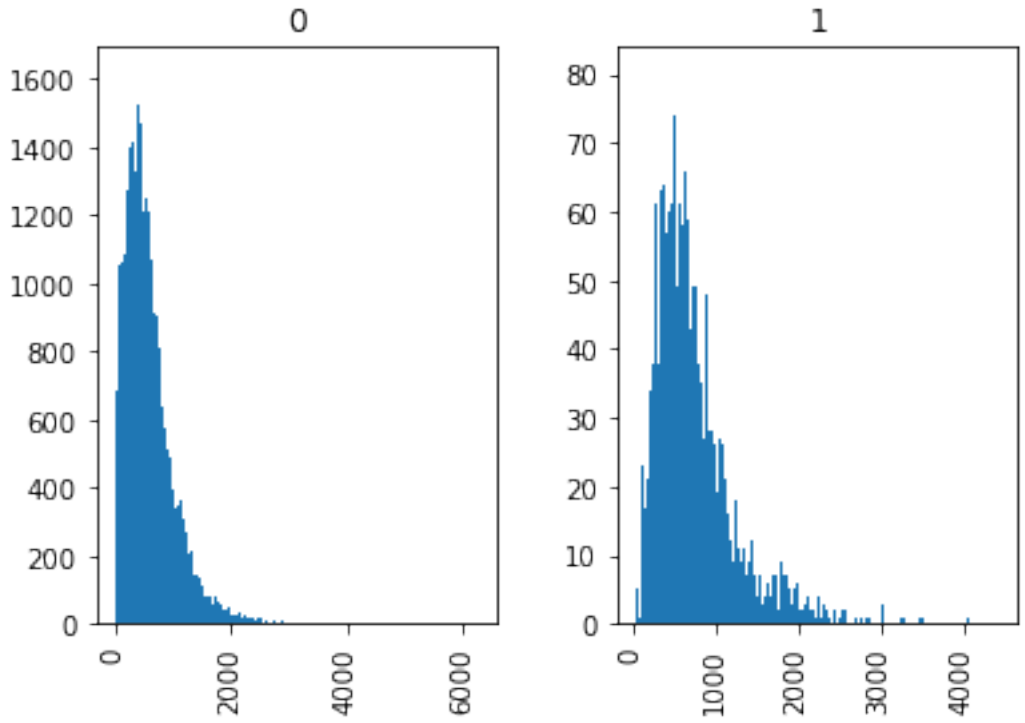
[70]:
```
                count        mean         std    min    25%    50%    75%  \
seafood_meal
0             95782.0  595.879560  442.124805    1.0  289.0  499.0  789.0
1              5949.0  752.167759  477.014340   40.0  431.0  643.0  943.0

                max
seafood_meal
0            6264.0
1            4451.0
```

Table: Statistical distribution of the KCAL variable within the 'seafood meal' groups, with 0 KCAL meals removed.

[71]:
```
#Seafood vs non seafood meals
df['DR1IKCAL'].hist(bins=500, by=df['seafood_meal'])
```

[71]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x7fe5c6b466a0>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x7fe5c4870fa0>],
```

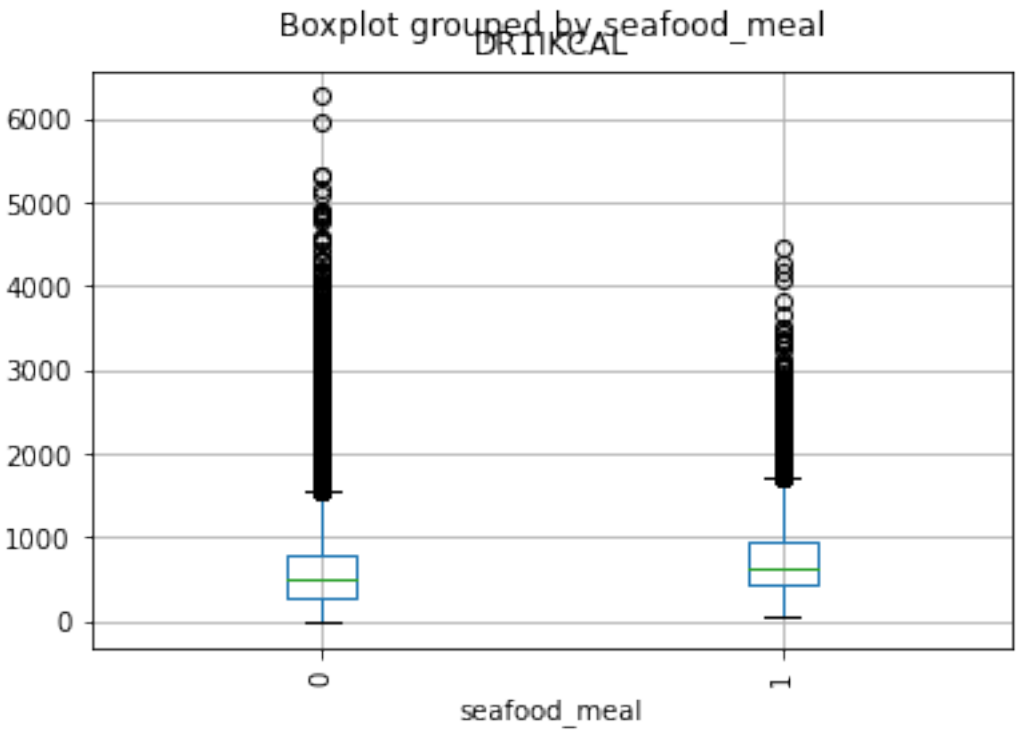
```
dtype=object)
```



Plot: Meal calories distribution with meals that are 0 KCAL removed, split by 'seafood meal' groups.

[86]:
```
df.boxplot(column='DR1IKCAL',by='seafood_meal',rot=90)
```

[86]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5b0515a30>
```



Plot: Boxplot of meal calories distribution with meals that are 0 KCAL removed, split by 'seafood meal' groups.

[72]:
```
#Seafood vs non seafood home and out
df.groupby(['seafood_meal','eathome'])['DR1IKCAL'].describe()
```

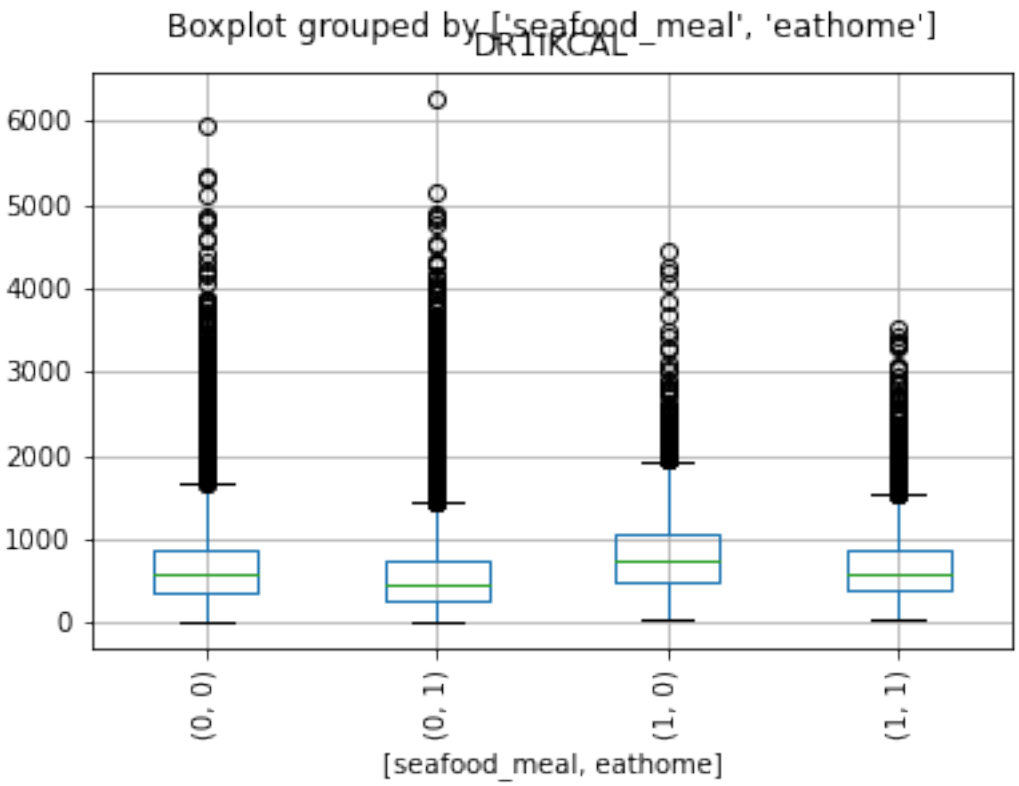
[72]:

seafood_meal	eathome	count	mean	std	min	25%	50%	75%	max
0	0	30638.0	675.534695	470.570282	1.0	352.00	576.0	885.00	5957.0
	1	65144.0	558.416800	422.941684	1.0	265.00	463.5	743.00	6264.0
1	0	2192.0	855.416971	527.356298	50.0	495.75	736.0	1073.25	4451.0
	1	3757.0	691.927602	433.886534	40.0	403.00	599.0	860.00	3509.0

Table: Statistical distribution of the KCAL variable within the 'seafood meal' groups, split by 'eathome', with 0 KCAL meals removed.

[87]:
```
df.boxplot(column='DR1IKCAL',by=['seafood_meal','eathome'],rot=90)
```

[87]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe5b05e1040>



Plot: Boxplot of meal calories distribution with meals that are 0 KCAL removed, split by 'seafood meal' and 'eathome' groups.

Section 1: Meal Energy Grouping

Create meal energy grouping based on quantiles from the 'KCAL' variable.

[73]:
```
#Create meal energy category based on quantiles from KCAL
df.loc[df['DR1IKCAL'] < df['DR1IKCAL'].describe()['25%'], 'meal_energy'] = "Low"
df.loc[(df['DR1IKCAL'] > df['DR1IKCAL'].describe()['25%'])
       & (df['DR1IKCAL'] < df['DR1IKCAL'].describe()['50%']), 'meal_energy'] =␣
 ↪"Medium-Low"
df.loc[(df['DR1IKCAL'] > df['DR1IKCAL'].describe()['50%'])
       & (df['DR1IKCAL'] < df['DR1IKCAL'].describe()['75%']), 'meal_energy'] =␣
 ↪"Medium-High"
df.loc[df['DR1IKCAL'] > df['DR1IKCAL'].describe()['75%'], 'meal_energy'] =␣
 ↪"High"

#Display top of new meal energy category
df[['SEQN', 'DR1IKCAL','meal_energy']].head(20)
```

[73]:

	SEQN	DR1IKCAL	meal_energy
0	31127	447.0	Medium-Low
1	31127	264.0	Low
2	31128	861.0	High
3	31129	867.0	High
4	31129	1150.0	High
5	31131	253.0	Low
6	31131	88.0	Low
7	31132	130.0	Low
8	31132	836.0	High
9	31132	491.0	Medium-Low
10	31133	843.0	High
11	31133	448.0	Medium-Low
12	31134	963.0	High
13	31134	1181.0	High
14	31135	332.0	Medium-Low
15	31135	501.0	Medium-Low
16	31137	720.0	Medium-High
17	31137	813.0	High
18	31138	314.0	Medium-Low
19	31138	204.0	Low

Table: Example of proposed meal energy categories.

Section 1: Questions

1. Why are there so many meals with 0 KCAL?
2. Why are the KCAL values so large? Looking at the statistics, these seem more like calories instead of kilo-calories.
3. Is the grouping method for this variable adequate?

Section 2: FPED Component Statistics

[74]:
```
#Create a list of the high level food components, as defined in the FPED
#Fruit, Vegetables, Grains, Protein Foods, and Dairy components
#Include oils, fats, and sugars at this level.
food_cmp_level1 = ['F_TOTAL','V_TOTAL','G_TOTAL','D_TOTAL','OILS',
                   'SOLID_FATS', 'ADD_SUGARS']


df[food_cmp_level1].describe()
```

[74]:

	F_TOTAL	V_TOTAL	G_TOTAL	D_TOTAL	\
count	101731.000000	101731.000000	101731.000000	101731.000000	
mean	0.190867	0.539173	2.096162	0.439611	
std	0.517877	0.727561	2.222114	0.717852	
min	0.000000	0.000000	0.000000	0.000000	
25%	0.000000	0.000000	0.560000	0.000000	
50%	0.000000	0.290000	1.670000	0.070000	

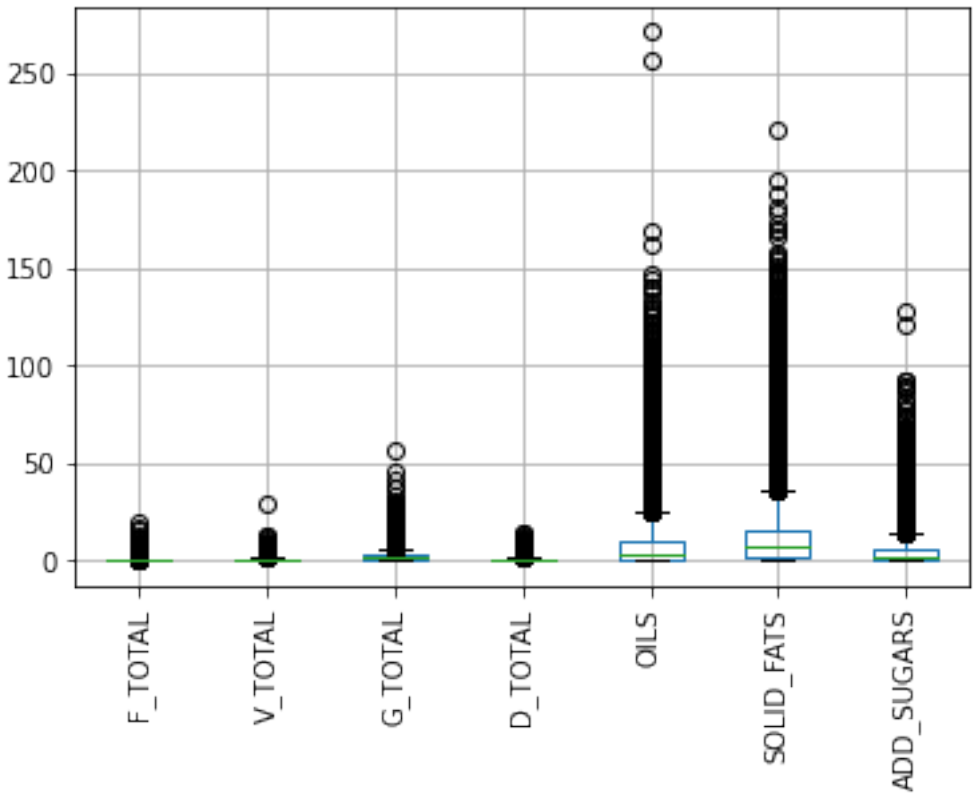
75%	0.040000	0.790000	2.870000	0.670000
max	19.640000	28.700000	56.650000	14.250000

	OILS	SOLID_FATS	ADD_SUGARS
count	101731.000000	101731.000000	101731.000000
mean	7.444314	10.615657	3.896764
std	10.633179	13.289950	5.863417
min	0.000000	0.000000	0.000000
25%	0.350000	1.210000	0.030000
50%	3.510000	6.440000	1.310000
75%	10.330000	14.920000	5.720000
max	271.030000	221.470000	128.280000

Table: statistical distribution of the Level 1 components.

[75]:
```
df[food_cmp_level1].boxplot(rot=90)
```

[75]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5cbe00310>
```

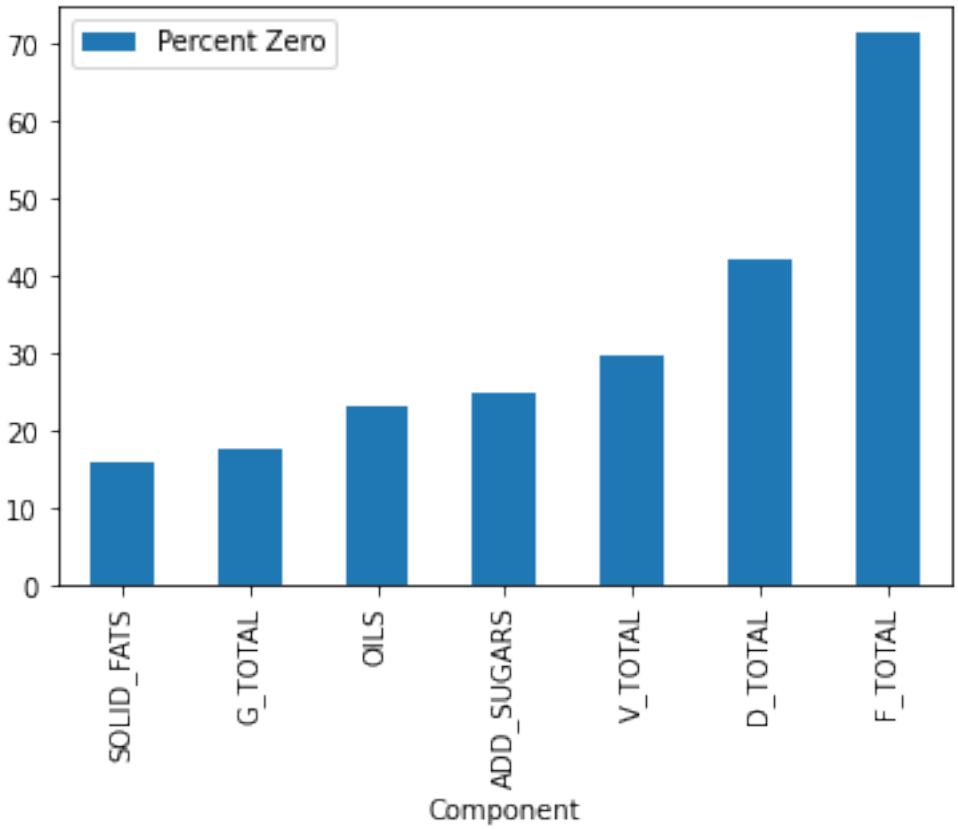


Plot: Boxplot of Level 1 components distribution.

[76]:
```
zero_count_table = []
for var in food_cmp_level1:
    zero_length = len(df[df[var]==0])
    non_zero_length = len(df[df[var]!=0])
    zero_count_table.append([var, zero_length, non_zero_length,␣
 ↪round((100*zero_length)/len(df),2)])

zero_count_table = pd.DataFrame(zero_count_table)
zero_count_table.columns = ['Component', 'Num Zero', 'Num Non Zero', 'Percent␣
 ↪Zero']
```

[77]:
```
zero_count_table.sort_values(by='Percent Zero').plot.
 ↪bar(x='Component',y='Percent Zero')
```

[77]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5d036e220>
```



Plot: Percentage of 0's count within Level 1 components.

[78]:
```
food_cmp_level5 = ['F_CITMLB', 'F_OTHER', 'F_JUICE',
```

```
                  'V_DRKGR', 'V_REDOR_TOMATO', 'V_REDOR_OTHER',␣
↪'V_STARCHY_POTATO',
                  'V_STARCHY_OTHER', 'V_OTHER', 'V_LEGUMES',
                  'G_WHOLE','G_REFINED',
                  'PF_EGGS', 'PF_SOY', 'PF_NUTSDS', 'PF_LEGUMES',
                  'D_MILK', 'D_YOGURT', 'D_CHEESE',
                  'OILS', 'SOLID_FATS', 'ADD_SUGARS']

df[food_cmp_level5[:-3]].describe()
```

[78]:

	F_CITMLB	F_OTHER	F_JUICE	V_DRKGR
count	101731.000000	101731.000000	101731.000000	101731.000000
mean	0.036061	0.083847	0.070955	0.046066
std	0.266438	0.315651	0.287517	0.211659
min	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.000000
50%	0.000000	0.000000	0.000000	0.000000
75%	0.000000	0.000000	0.000000	0.000000
max	18.940000	8.280000	7.970000	6.400000

	V_REDOR_TOMATO	V_REDOR_OTHER	V_STARCHY_POTATO	V_STARCHY_OTHER
count	101731.000000	101731.000000	101731.000000	101731.000000
mean	0.113322	0.032593	0.123518	0.034165
std	0.233921	0.127866	0.326874	0.156891
min	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.000000
50%	0.000000	0.000000	0.000000	0.000000
75%	0.130000	0.000000	0.000000	0.000000
max	5.030000	3.970000	6.760000	6.580000

	V_OTHER	V_LEGUMES	G_WHOLE	G_REFINED
count	101731.000000	101731.000000	101731.000000	101731.000000
mean	0.189509	0.050802	0.143051	1.953103
std	0.400805	0.210966	0.534355	2.202882
min	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.360000
50%	0.000000	0.000000	0.000000	1.440000
75%	0.210000	0.000000	0.000000	2.710000
max	28.700000	6.730000	22.550000	56.650000

	PF_EGGS	PF_SOY	PF_NUTSDS	PF_LEGUMES
count	101731.000000	101731.000000	101731.000000	101731.000000
mean	0.092461	0.015541	0.073137	0.203421
std	0.362471	0.163278	0.529916	0.844649
min	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.000000
50%	0.000000	0.000000	0.000000	0.000000

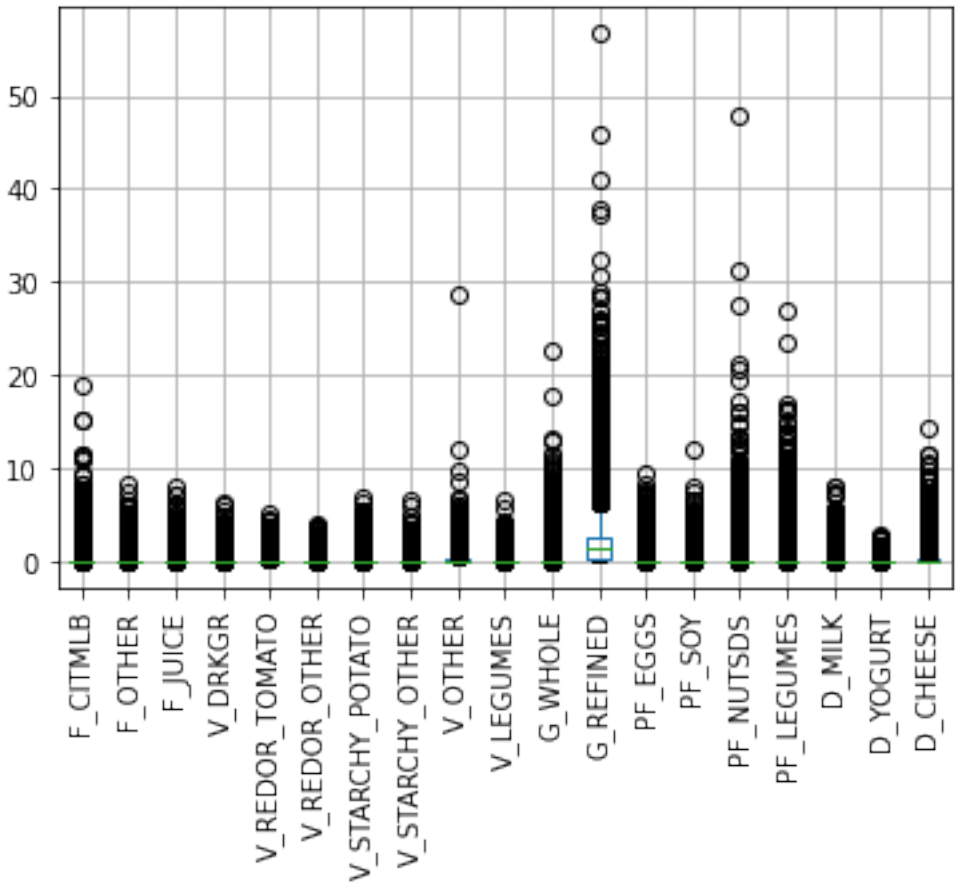
75%	0.020000	0.000000	0.000000	0.000000
max	9.600000	11.910000	48.000000	27.050000

	D_MILK	D_YOGURT	D_CHEESE
count	101731.000000	101731.000000	101731.000000
mean	0.162978	0.008339	0.265339
std	0.417030	0.074552	0.580337
min	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000
50%	0.000000	0.000000	0.000000
75%	0.060000	0.000000	0.320000
max	8.040000	2.760000	14.250000

Table: statistical distribution of the Level 5 components.

[79]:
```
df[food_cmp_level5[:-3]].boxplot(rot=90)
```

[79]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5d01c0f70>
```

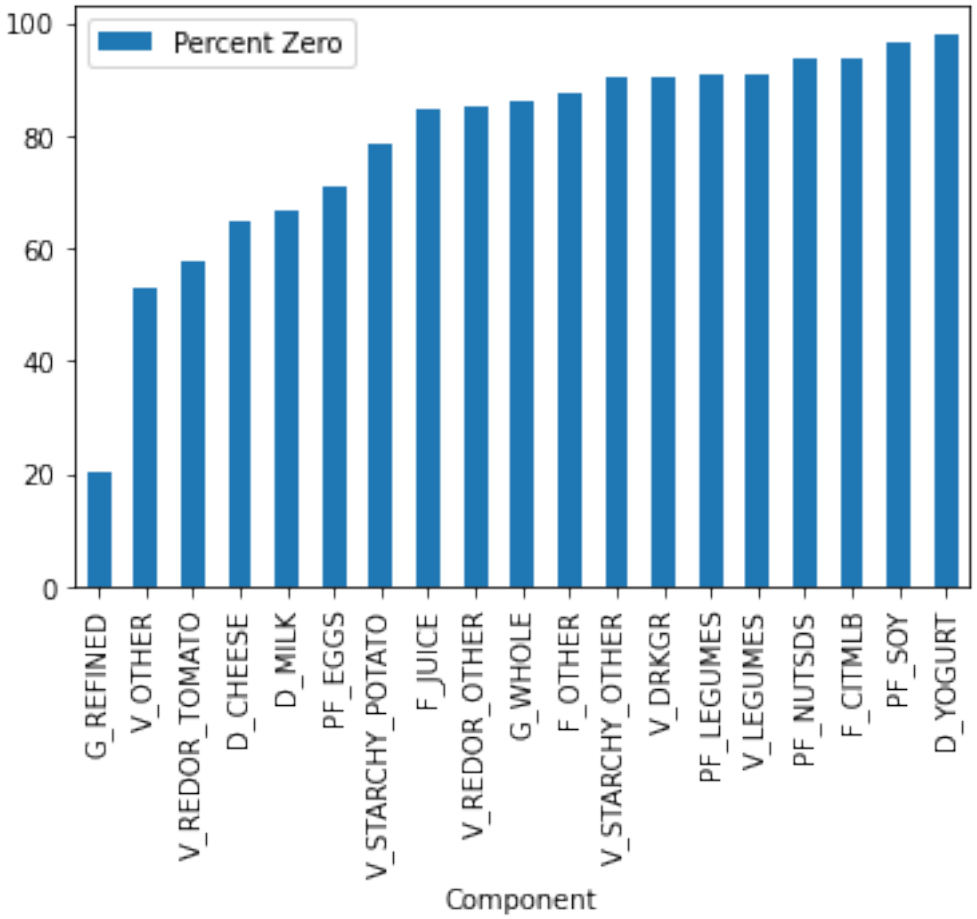


Plot: Boxplot of Level 5 components distribution.

[80]:
```
zero_count_table = []
for var in food_cmp_level5[:-3]:
    zero_length = len(df[df[var]==0])
    non_zero_length = len(df[df[var]!=0])
    zero_count_table.append([var, zero_length, non_zero_length,␣
 ↪round((100*zero_length)/len(df),2)])

zero_count_table = pd.DataFrame(zero_count_table)
zero_count_table.columns = ['Component', 'Num Zero', 'Num Non Zero', 'Percent␣
 ↪Zero']
```

[81]:
```
zero_count_table.sort_values(by='Percent Zero').plot.
 ↪bar(x='Component',y='Percent Zero')
```

[81]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe5b2a8aa90>



Plot: Percentage of 0's count within Level 5 components.

Section 2: Questions

1. Would it be useful to use categories instead of quantities for the FPED components, due to the high number of 0's? The categories could be two, or more than two factors. For example, a two factor category could include: 'Yes' for any quantity > 0 and 'No' for quantities that are 0. A multi factor category could include: 'None' for any quantity that is 0, and the rest can be divided to 'Low', 'Medium', 'High', etc.

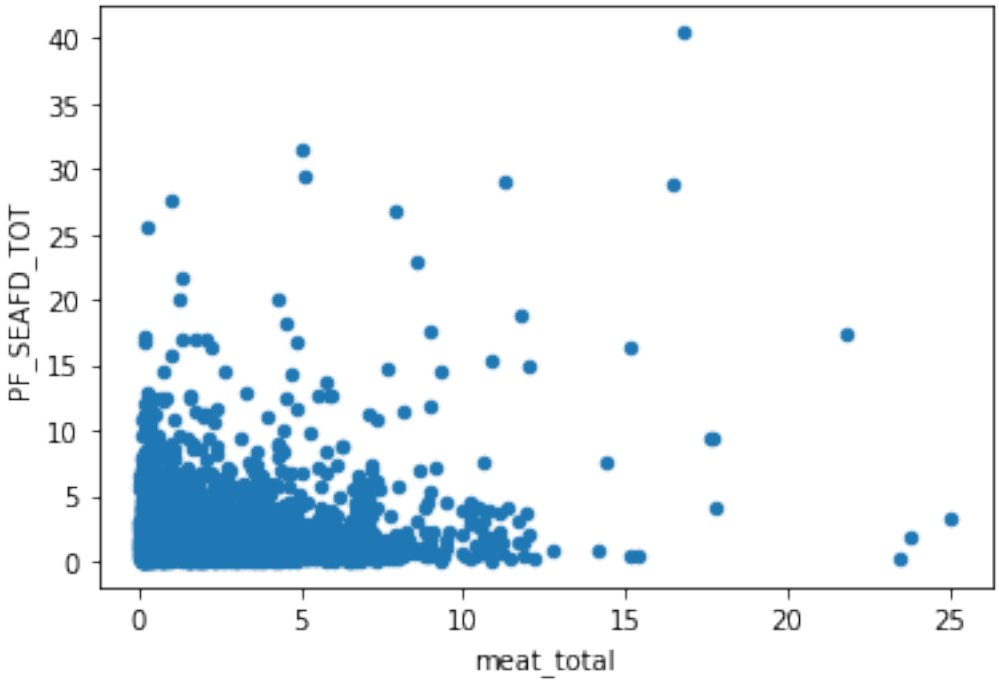
Section 3: Meal Types

[128]:
```
df['meat_total'] =␣
 ↪df['PF_MEAT']+df['PF_POULT']+df['PF_ORGAN']+df['PF_CUREDMEAT']
meals_contain_meat = df[df['meat_total']>0]
print("Number of meals that contain meat: "+str(len(meals_contain_meat)))
meals_contain_seafood = df[df['PF_SEAFD_TOT']>0]
print("Number of meals that contain seafood: "+str(len(meals_contain_seafood)))
meals_contain_both = df[(df['PF_SEAFD_TOT']>0) & (df['meat_total']>0)]
print("Number of meals that contain both meat and seafood:␣
 ↪"+str(len(meals_contain_both)))
meals_contain_none = df[(df['PF_SEAFD_TOT']==0) & (df['meat_total']==0)]
print("Number of meals that contain no meat and no seafood:␣
 ↪"+str(len(meals_contain_none)))
```

```
Number of meals that contain meat: 65820
Number of meals that contain seafood: 7709
Number of meals that contain both meat and seafood: 2346
Number of meals that contain no meat and no seafood: 31529
```

[130]:
```
meals_contain_both.plot.scatter(x='meat_total', y='PF_SEAFD_TOT')
```

[130]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe5a05a4c40>
```



The plot above is showing the meat and seafood quantities in meals that contain both.

Section 3: Questions

1. Can vegeterian meals be excluded and study focuses on seafood vs meat meals?
2. Can meals that contain both seafood and meat be excluded? Or should they be classified based on some threshold?