Project: Investigate a Dataset - [Medical Appointment No Shows]

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Introduction

Dataset Description

This dataset collects information from 100k medical appointments in Brazil and is focused on the question of whether or not patients show up for their appointment. These are the column names with their description;

- PatientId - Identification of a patient
- AppointmentID - Identification of each appointment
- Gender - Male or Female
- AppointmentDay - The day of the actuall appointment, when they have to visit the doctor.
- ScheduledDay - The day someone called or registered the appointment, this is before appointment of course.
- Age - How old is the patient.
- Neighbourhood - The location of the hospital.
- Scholarship - Indicates whether or not the patient is enrolled in Brasilian welfare program (True of False).
- Hipertension - Boolean
- Diabetes - Boolean
- Alcoholism - Boolean
- Handcap - Boolean
- SMS_received - 1 or more messages sent to the patient (Boolean)
- No-show- Boolean.

Question(s) for Analysis

- Do patients with special ailments show up more?
- Do younger patients show up compared to older patients?
- If a patient recieves an sms, is he likey to show up?
- Do females show up more than males?

In [1]:
```
# import libraries
import numpy as np
import pandas as pd
```

```
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Data Wrangling

In [24]:
```
# Read data from csv and print the first five rows
df = pd.read_csv('medical_appointments.csv')
df.head()
```

Out[24]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scholarsl
0	2.987250e+13	5642903	F	2016-04-29T18:38:08Z	2016-04-29T00:00:00Z	62	JARDIM DA PENHA	
1	5.589978e+14	5642503	M	2016-04-29T16:08:27Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	
2	4.262962e+12	5642549	F	2016-04-29T16:19:04Z	2016-04-29T00:00:00Z	62	MATA DA PRAIA	
3	8.679512e+11	5642828	F	2016-04-29T17:29:31Z	2016-04-29T00:00:00Z	8	PONTAL DE CAMBURI	
4	8.841186e+12	5642494	F	2016-04-29T16:07:23Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	

In [25]:
```
# Get more information about the columns
df.info() #There are no missing values
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 110527 entries, 0 to 110526
Data columns (total 14 columns):
 #   Column          Non-Null Count   Dtype  
---  ------          --------------   -----  
 0   PatientId       110527 non-null  float64
 1   AppointmentID   110527 non-null  int64  
 2   Gender          110527 non-null  object 
 3   ScheduledDay    110527 non-null  object 
 4   AppointmentDay  110527 non-null  object 
 5   Age             110527 non-null  int64  
 6   Neighbourhood   110527 non-null  object 
 7   Scholarship     110527 non-null  int64  
 8   Hipertension    110527 non-null  int64  
 9   Diabetes        110527 non-null  int64  
 10  Alcoholism      110527 non-null  int64  
 11  Handcap         110527 non-null  int64  
 12  SMS_received    110527 non-null  int64  
 13  No-show         110527 non-null  object 
dtypes: float64(1), int64(8), object(5)
memory usage: 11.8+ MB
```

From the summary above, there are no null values but some inconsistencies were noticed in the datatypes:

- The PatientId column should be int,
- The boolean columns(scholarship,hipertension,diabetes, alcoholism,handicap,sms_received) were saved as int (it does not pose any problem).
- The No-show column should be an int(to represent 0 or 1)

In [26]:
```
# Compute Statistics such as mean, percentiles etc
df.describe()
```

Out[26]:

	PatientId	AppointmentID	Age	Scholarship	Hipertension	Diabetes	Alc
count	1.105270e+05	1.105270e+05	110527.000000	110527.000000	110527.000000	110527.000000	110527.
mean	1.474963e+14	5.675305e+06	37.088874	0.098266	0.197246	0.071865	0.
std	2.560949e+14	7.129575e+04	23.110205	0.297675	0.397921	0.258265	0
min	3.921784e+04	5.030230e+06	-1.000000	0.000000	0.000000	0.000000	0.
25%	4.172614e+12	5.640286e+06	18.000000	0.000000	0.000000	0.000000	0.
50%	3.173184e+13	5.680573e+06	37.000000	0.000000	0.000000	0.000000	0.
75%	9.439172e+13	5.725524e+06	55.000000	0.000000	0.000000	0.000000	0.
max	9.999816e+14	5.790484e+06	115.000000	1.000000	1.000000	1.000000	1.

In [27]:
```
df.query("Age == 115")
```

Out[27]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Sch
63912	3.196321e+13	5700278	F	2016-05-16T09:17:44Z	2016-05-19T00:00:00Z	115	ANDORINHAS	
63915	3.196321e+13	5700279	F	2016-05-16T09:17:44Z	2016-05-19T00:00:00Z	115	ANDORINHAS	
68127	3.196321e+13	5562812	F	2016-04-08T14:29:17Z	2016-05-16T00:00:00Z	115	ANDORINHAS	
76284	3.196321e+13	5744037	F	2016-05-30T09:44:51Z	2016-05-30T00:00:00Z	115	ANDORINHAS	
97666	7.482346e+14	5717451	F	2016-05-19T07:57:56Z	2016-06-03T00:00:00Z	115	SÃO JOSÉ	

In [28]:
```
dup = df.duplicated(subset=["PatientId", "AppointmentDay"])
df[dup]
```

Out[28]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Sch
27	1.215484e+13	5628345	F	2016-04-27T10:51:45Z	2016-04-29T00:00:00Z	4	CONQUISTA	
154	1.925263e+10	5636933	F	2016-04-28T16:38:34Z	2016-04-29T00:00:00Z	30	ITARARÉ	
288	2.246214e+13	5532908	M	2016-03-31T12:39:06Z	2016-04-29T00:00:00Z	43	CARATOÍRA	
290	7.222383e+12	5566070	M	2016-04-11T09:50:18Z	2016-04-29T00:00:00Z	7	CARATOÍRA	
316	1.756579e+13	5582867	F	2016-04-14T10:01:09Z	2016-04-29T00:00:00Z	1	JOANA D´ARC	
...	...	...	...	...	...	...	...	
110505	5.667344e+13	5758455	F	2016-06-01T10:45:50Z	2016-06-01T00:00:00Z	55	MARIA ORTIZ	
110507	4.769462e+14	5786918	F	2016-06-08T09:04:18Z	2016-06-08T00:00:00Z	0	MARIA ORTIZ	
110510	2.362182e+13	5757587	F	2016-06-	2016-06-	64	SOLON BORGES	

				01T09:35:48Z	01T00:00:00Z		
110514	2.695685e+12	5786567	F	2016-06-08T08:35:31Z	2016-06-08T00:00:00Z	58	MARIA ORTIZ
110515	6.456342e+14	5778621	M	2016-06-06T15:58:05Z	2016-06-08T00:00:00Z	33	MARIA ORTIZ

8719 rows × 14 columns

I noticed the max age is 115 so, it got me curious to observe the data and noticed that there are duplicate appointment days (8719 rows).

- These duplicate appointment days were scheduled by the same patient and some were on the same day with the appointment date displaying few seconds apart. I believe it might be an error while scheduling an appointment. #### The Handicap column has 4 as a max value which is a boolean column and should have onlu have 0's and 1's. #### The Age column has a -1 as a min value. I believe this is recorded as an infant aged below one year. #### The patientId and AppointmentID columns will be removed as they are not needed for analyzing the dataset.

In [29]:
```
# Get the dimensions
df.shape
```

Out[29]:
```
(110527, 14)
```

Data Cleaning

In [30]:
```
# Change the column type from float to int
df['PatientId'] = df['PatientId'].astype(int)
```

In [31]:
```
# This column should be boolean. Here, I am replacing No with 0 and Yes with 1
df['No-show'] = df['No-show'].replace({'No': 0, 'Yes': 1})
df.head()
```

Out[31]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scho
0	29872499824296	5642903	F	2016-04-29T18:38:08Z	2016-04-29T00:00:00Z	62	JARDIM DA PENHA	
1	558997776694438	5642503	M	2016-04-29T16:08:27Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	
2	4262962299951	5642549	F	2016-04-29T16:19:04Z	2016-04-29T00:00:00Z	62	MATA DA PRAIA	
3	867951213174	5642828	F	2016-04-29T17:29:31Z	2016-04-29T00:00:00Z	8	PONTAL DE CAMBURI	
4	8841186448183	5642494	F	2016-04-29T16:07:23Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	

In [32]:
```
# for consistency, I renamed these columns
df.rename(columns={"SMS_received": "SmsReceived", "No-show": "NoShow"}, inplace=True)
df.head()
```

Out[32]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scho
0	29872499824296	5642903	F	2016-04-29T18:38:08Z	2016-04-29T00:00:00Z	62	JARDIM DA PENHA	

1	558997776694438	5642503	M	2016-04-29T16:08:27Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA
2	4262962299951	5642549	F	2016-04-29T16:19:04Z	2016-04-29T00:00:00Z	62	MATA DA PRAIA
3	867951213174	5642828	F	2016-04-29T17:29:31Z	2016-04-29T00:00:00Z	8	PONTAL DE CAMBURI
4	8841186448183	5642494	F	2016-04-29T16:07:23Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA

In [7]:
```
df.rename(columns={"SMS_received": "SmsReceived", "No-show": "NoShow"}, inplace=True)
df.head()
```

Out[7]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scho
0	29872499824296	5642903	F	2016-04-29T18:38:08Z	2016-04-29T00:00:00Z	62	JARDIM DA PENHA	
1	558997776694438	5642503	M	2016-04-29T16:08:27Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	
2	4262962299951	5642549	F	2016-04-29T16:19:04Z	2016-04-29T00:00:00Z	62	MATA DA PRAIA	
3	867951213174	5642828	F	2016-04-29T17:29:31Z	2016-04-29T00:00:00Z	8	PONTAL DE CAMBURI	
4	8841186448183	5642494	F	2016-04-29T16:07:23Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	

In [34]:
```
# remove duplicate appointments
df.drop_duplicates(subset=["PatientId", "AppointmentDay"], inplace=True)
df.shape
```

Out[34]:
```
(101808, 14)
```

In [35]:
```
# The duplicate appointment has been removed
df.query("Age == 115")
```

Out[35]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood
63912	31963211613981	5700278	F	2016-05-16T09:17:44Z	2016-05-19T00:00:00Z	115	ANDORINHAS
68127	31963211613981	5562812	F	2016-04-08T14:29:17Z	2016-05-16T00:00:00Z	115	ANDORINHAS
76284	31963211613981	5744037	F	2016-05-30T09:44:51Z	2016-05-30T00:00:00Z	115	ANDORINHAS
97666	748234579244724	5717451	F	2016-05-19T07:57:56Z	2016-06-03T00:00:00Z	115	SÃO JOSÉ

In [36]:
```
# remove these columns as they are irrelevant to analysis
df.drop(['PatientId', 'AppointmentID'], axis=1, inplace=True)
```

In [37]:
```
def drop_handicap_outlier(value):
    for x in value:
        dfl = df[df.Handcap == x].index
        df.drop(dfl, inplace=True)
```

In [38]:
```
# remove extra values since the column is boolean and should contain only 1 and 0
values = (2,3,4)
```

```
drop_handicap_outlier(values)
```

In [39]:
```
# check distinct elements in the column
df.Handcap.unique()
```

Out[39]:
```
array([0, 1])
```

Observations are;

- Generally, more people showed up for their appointments.
- Most of the patients are children.
- Very few patient had other diseases and disability but still show up regardless.
- Location could have been provided to determine if accessilibilty was an issue.

Exploratory Data Analysis

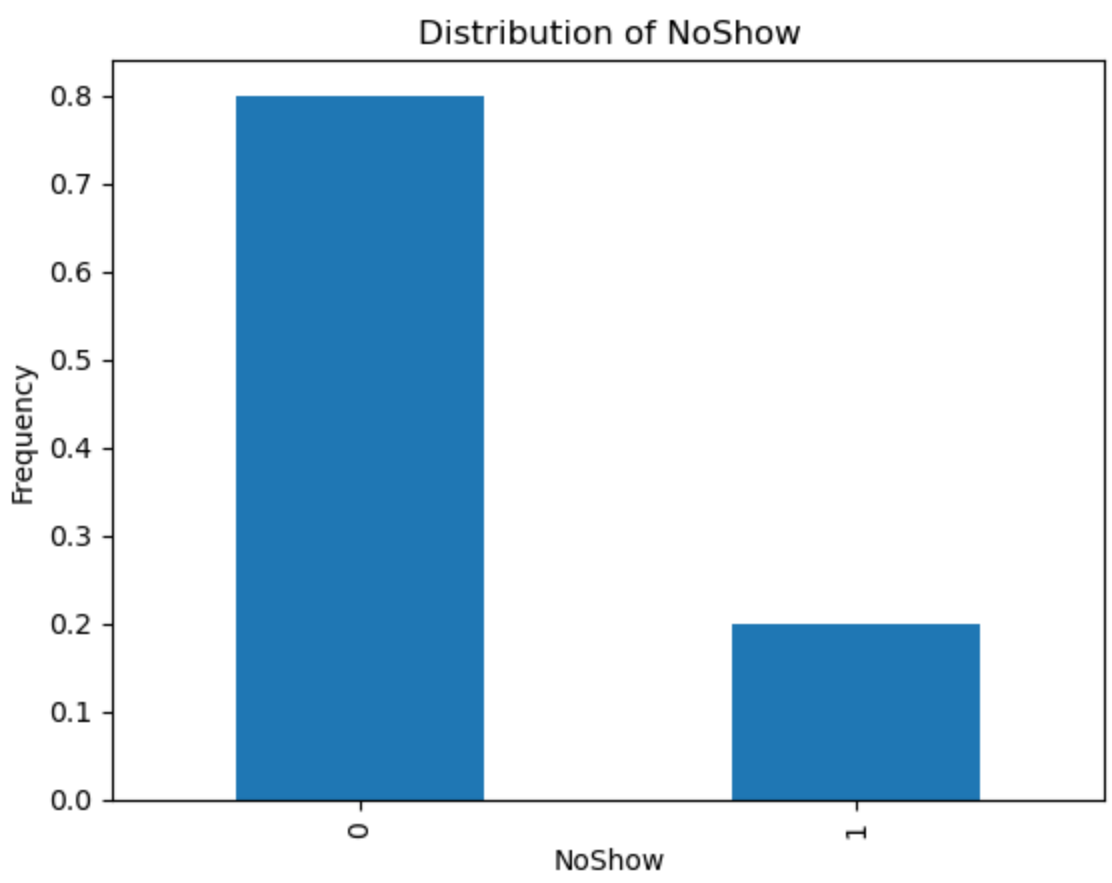
Do patients with special ailments show up more?

From the dataset, there is information about patient with special conditions such as diabetes, hipertnsion etc. My analysis is to check if these patients attend their scheduled appointment more than patients with no such conditions.

> Note: 0 - No, 1 - Yes

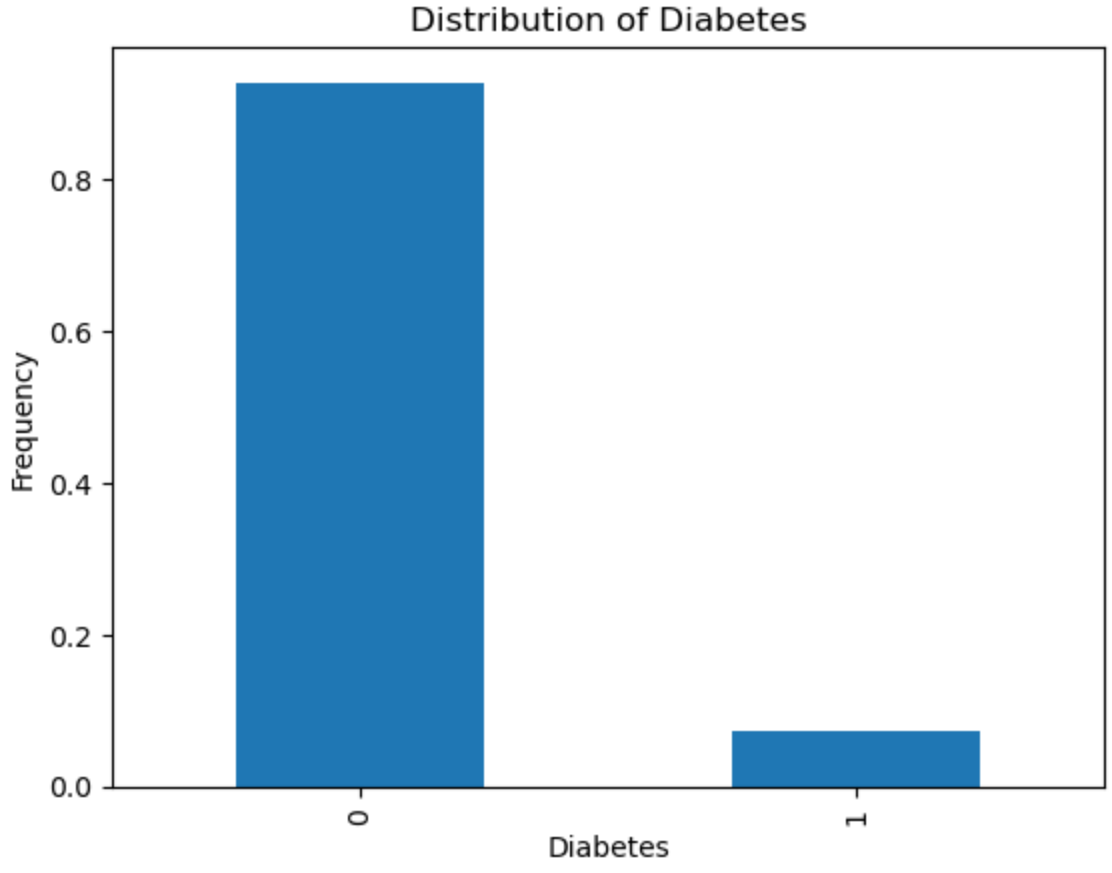
In [41]:
```
def visualize_data(ailment):
    df[ailment].value_counts(normalize=True).plot.bar()
    plt.xlabel(ailment)
    plt.ylabel("Frequency")
    plt.title(f"Distribution of {ailment}")
```

In [43]:
```
visualize_data("NoShow")
```

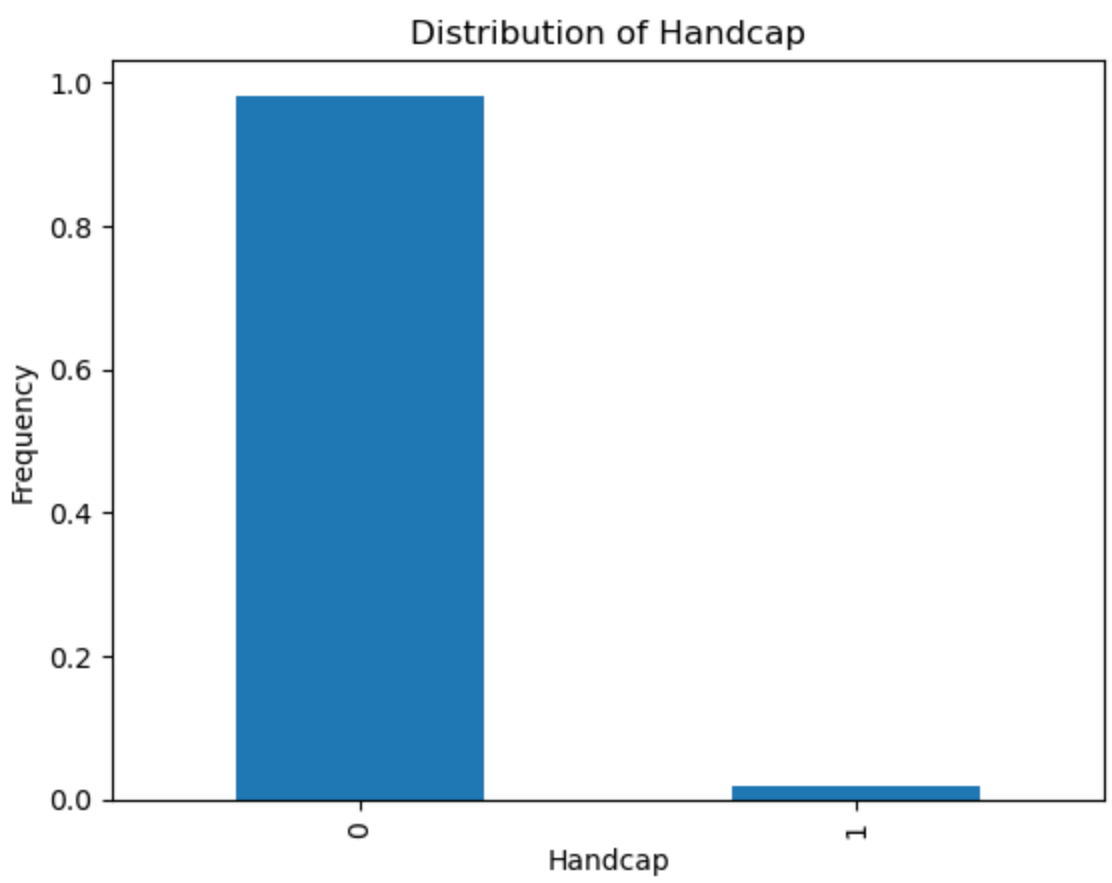


In [ ]:
```
df["Diabetes"].value_counts(normalize=True).plot.bar()
```

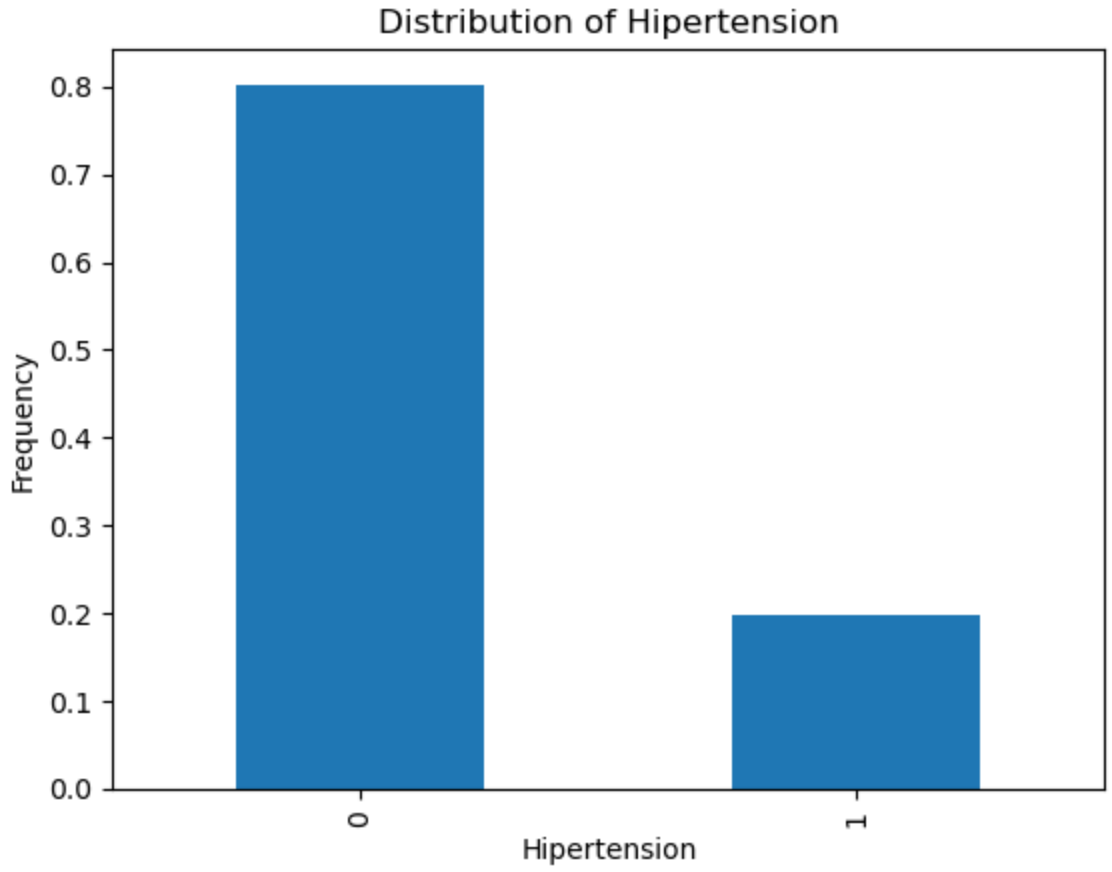
In [44]:
```
visualize_data("Diabetes")
```



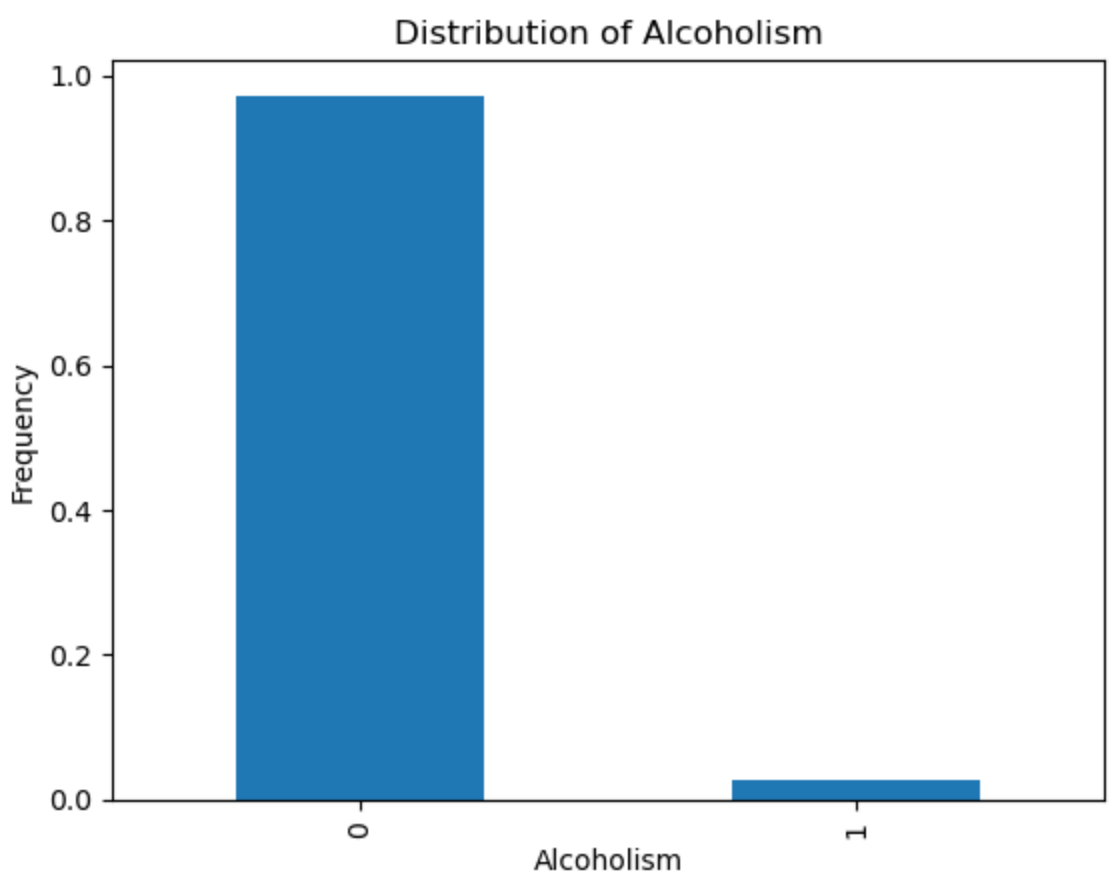
In [45]:
```
visualize_data("Handcap")
```



In [46]:
```
visualize_data("Hipertension")
```



In [47]:
```
visualize_data("Alcoholism")
```

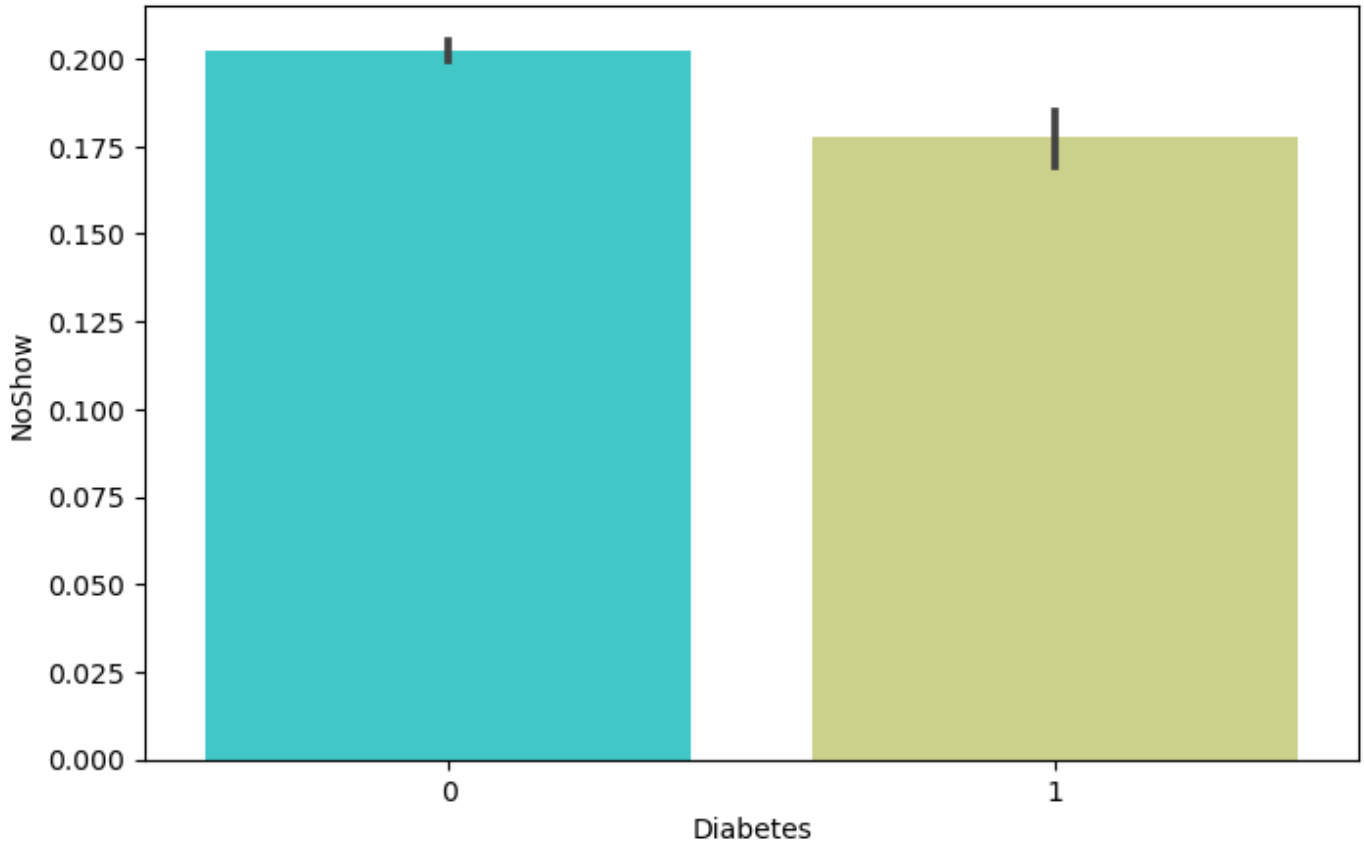


Generally, more patients attended their appointments. I believe the assumption of patients not showing up was because of the duplicate appointment dates.

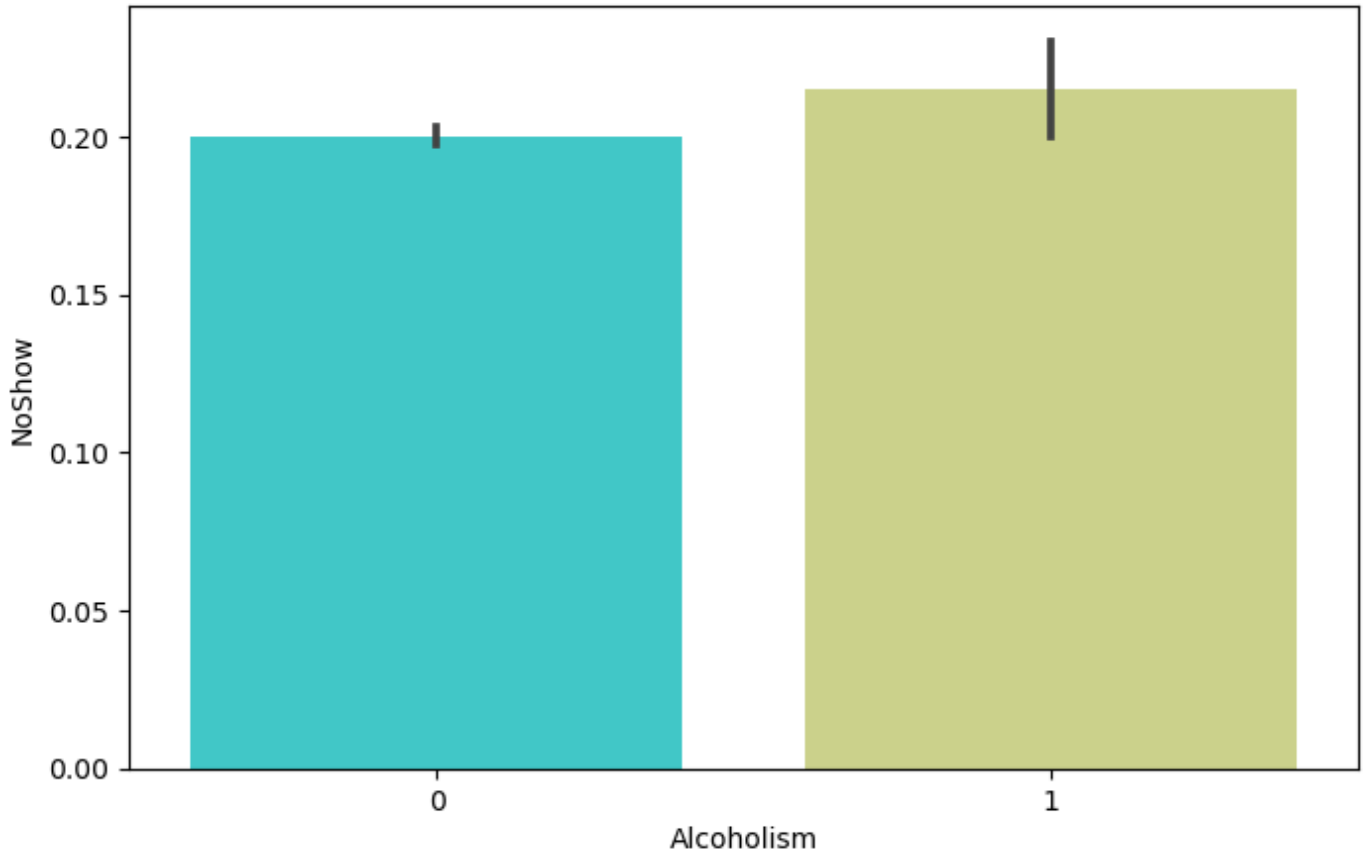
For the visualize_data function, I am checking to see the data distribution of each special ailment.From the bar chart, there are lesser patients with these special ailments.

In [48]:
```
def visualize_data_relation(x_var):
    plt.figure(figsize=(8,5))
    sns.barplot(x=x_var,y="NoShow",data=df, palette='rainbow')
```

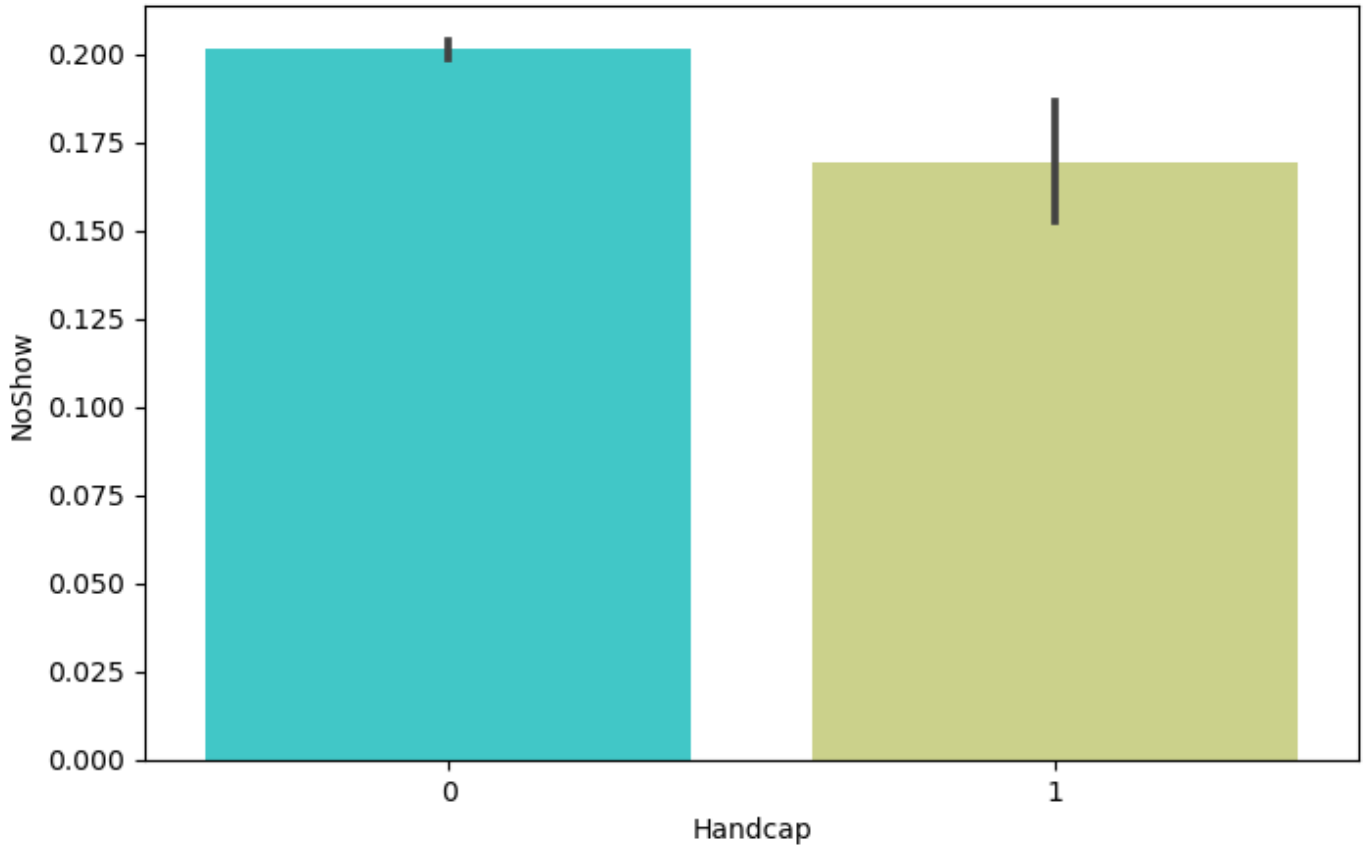
In [49]:
```
visualize_data_relation("Diabetes")
```



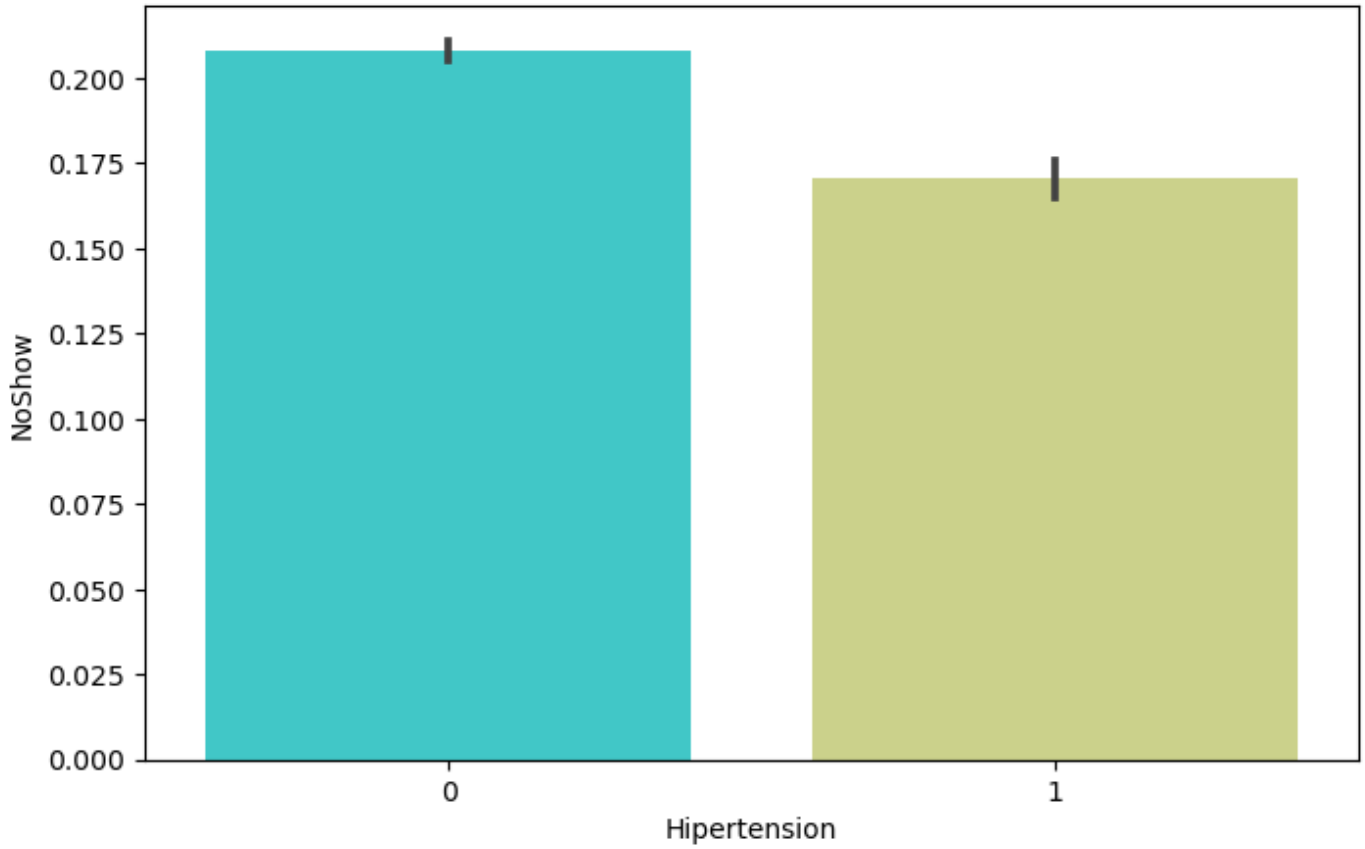
In [50]:
```
visualize_data_relation("Alcoholism")
```



In [51]:
```
visualize_data_relation("Handcap")
```



In [52]:
```
visualize_data_relation("Hipertension")
```



From the visualize_data_relation function, I compared the distribution of each ailment with the data of those that attended their appointments or not.

The following was noticed:

- With patients diagnosed of alcholism,more of them attended their appointment.

- With other ailment such as diabetes, hipertension and Handcap, patients showed up less for their appointment.

Do younger patients show up compared to older patients?

In [53]:
```
# Get a count of unique rows for age groups
show = df.NoShow == 0 # attended appointment
noshow = df.NoShow == 1 # did not attend appointment
df.Age.value_counts().sort_index()
```

Out[53]:
```
-1         1
 0      3352
 1      2161
 2      1533
 3      1416
       ...
 98        5
 99        1
 100       3
 102       2
 115       4
Name: Age, Length: 104, dtype: int64
```

In [54]:
```
# Get a count of unique rows for age groups that didn't attend their appointment
df.Age[noshow].value_counts().sort_index()
```

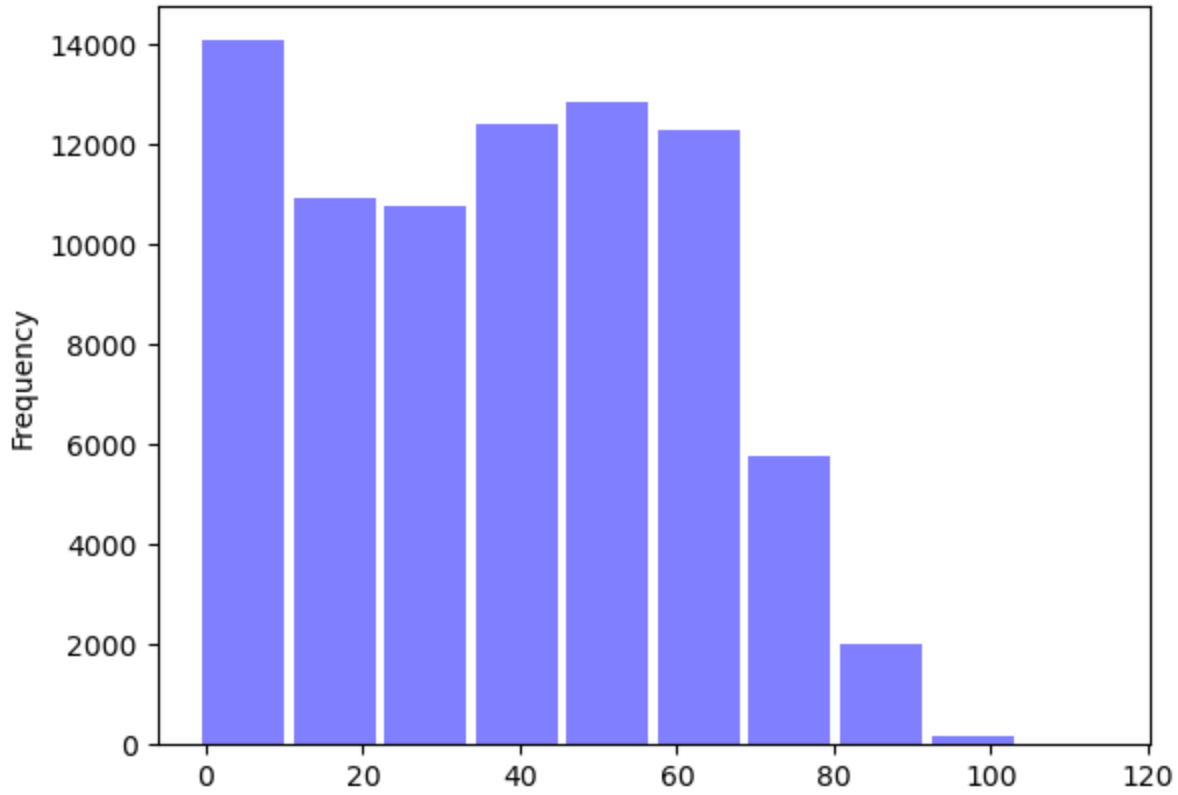
Out[54]:
```
0      600
1      391
2      232
3      252
4      264
      ...
95       6
96       1
97       2
98       1
115      2
Name: Age, Length: 100, dtype: int64
```

In [55]:
```
# Get a count of unique rows for age groups that attended their appointment
df.Age[show].value_counts().sort_index()
```

Out[55]:
```
-1         1
 0      2752
 1      1770
 2      1301
 3      1164
       ...
 98        4
 99        1
 100       3
 102       2
 115       2
Name: Age, Length: 104, dtype: int64
```

In [56]:
```
df.Age[show].plot(kind='hist', alpha=0.5, color='blue',rwidth=0.9, label='Appointment')
```

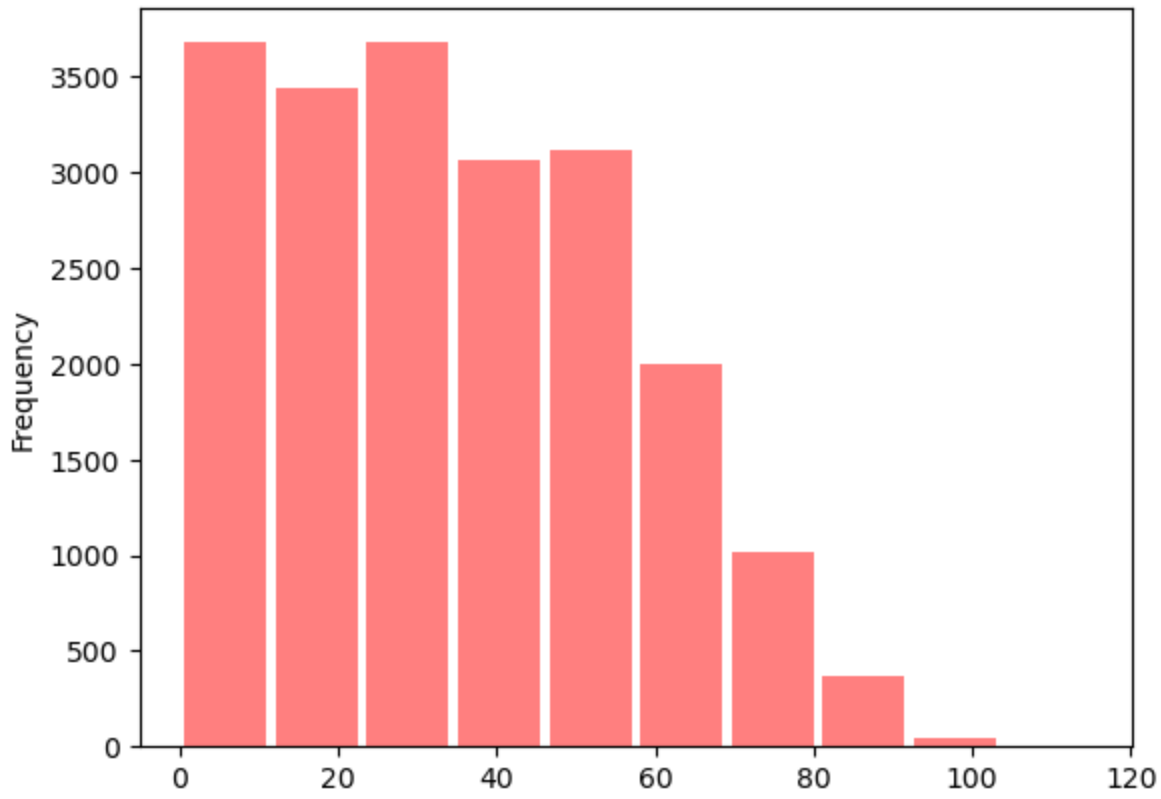
Out[56]:
```
<AxesSubplot:ylabel='Frequency'>
```



From the chart above, younger patients within the age group of 0-10 years attended their appointment mostly. Patients older than 90years attended the least, this can be due to the age mortality rate.

In [57]:
```
df.Age[noshow].plot(kind='hist', alpha=0.5, color='red', rwidth=0.9, label='No Appointme
```

Out[57]:
```
<AxesSubplot:ylabel='Frequency'>
```



From the chart above, patients within the age group of 0-10 and 25-35 years attended their appointment mostly.

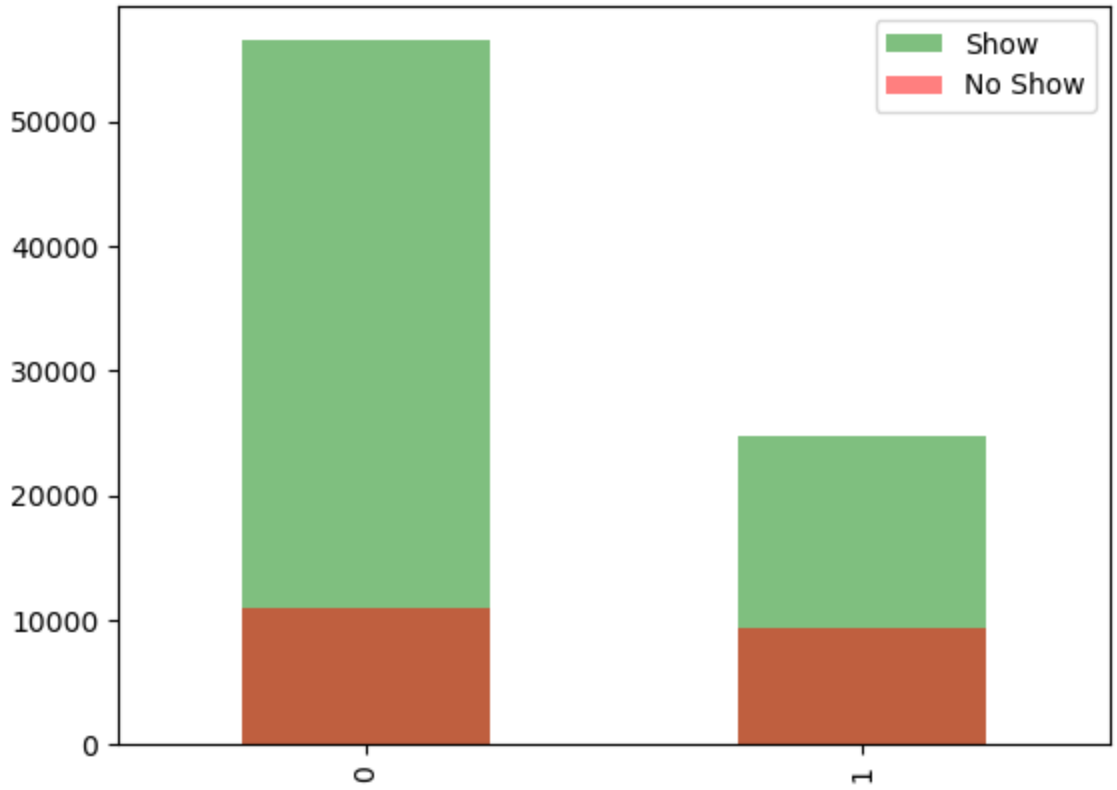
If a patient recieves an sms, is he likey to show up?

In [58]:
```
df.SmsReceived[noshow].value_counts()
```

Out[58]:
```
0    11046
1     9341
Name: SmsReceived, dtype: int64
```

In [59]:
```
df.SmsReceived[show].value_counts().plot(kind='bar', alpha=0.5, color='green', label='Sh
df.SmsReceived[noshow].value_counts().plot(kind='bar', alpha=0.5, color='red', label='No
plt.legend()
```

Out[59]:
```
<matplotlib.legend.Legend at 0x16a604190>
```

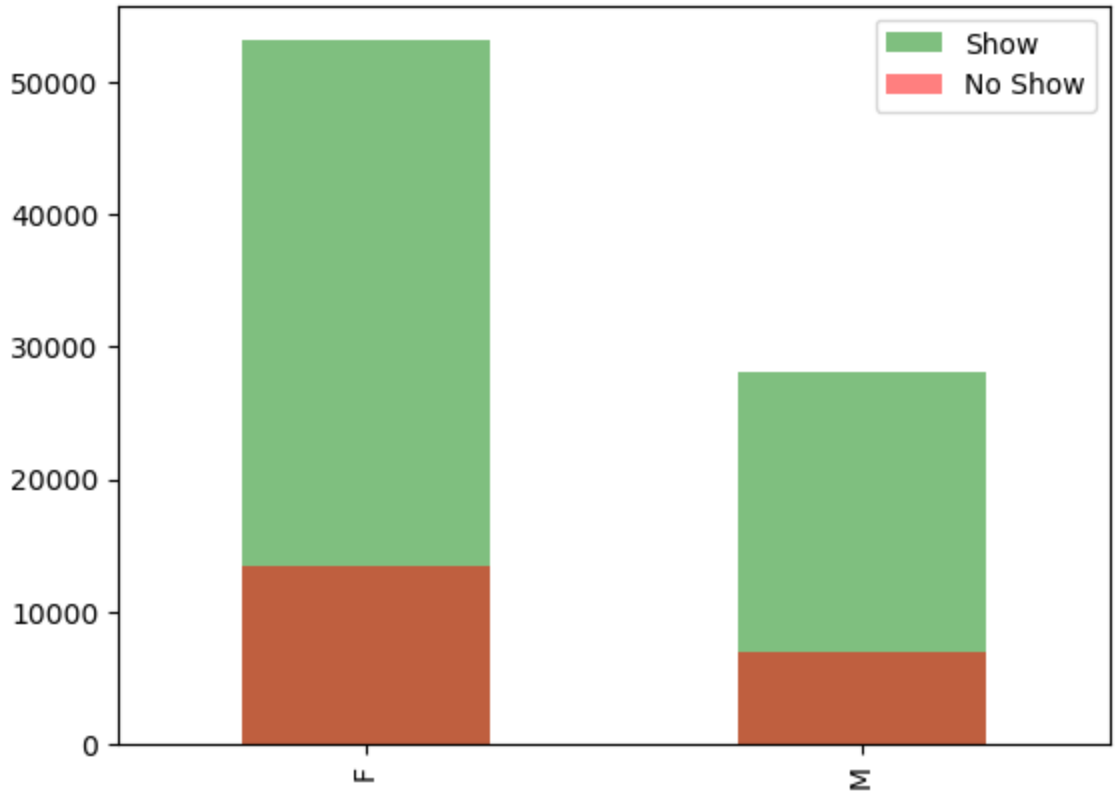


Irrespective of whether an sms was received, patients still attended their appointment.¶

Do females show up more then males?

In [60]:
```
df.Gender[show].value_counts().plot(kind='bar', alpha=0.5, color='green', label='Show')
df.Gender[noshow].value_counts().plot(kind='bar', alpha=0.5, color='red', label='No Show
plt.legend()
```

Out[60]:
```
<matplotlib.legend.Legend at 0x16a604160>
```



From the chart, more females attended their appointment compared to males.

Conclusions

The following were deduced from the analysis;

- More patients attended their appointment regardless of special ailments, whether an SMS was recieved or not.
- Younger ones attended their appointment more, probably because they need more care and are more prone to sickeness due to their tender age.
- More Females attended their appointment than males. This maybe because females are more concerned about their health than males who can be carefree most times.

> A limitation in the analysis is, if the location of the patient was provided to determine whether distance to the hospital is a factor to consider.