In [1]:

```
# %%
import os
import pandas as pd
import seaborn as sns
from scipy.stats import shapiro, monte_carlo_test
import scipy.stats as st
import numpy as np
import matplotlib.pyplot as plt
from scipy import stats
import statsmodels.api as sm
from stats_test import shapiro_test
path = os.path.join(os.getcwd(), 'datasets','Birthweight.csv')
dataset = pd.read_csv(path, sep=',', decimal='.')

dataset.head()
```

Out[1]:

	ID	Length	Birthweight	Headcirc	Gestation	smoker	mage	mnocig	mheight	mppwt	fage	fedyrs	fnocig	fheight	lowbwt	mage35
0	1360	56	4.55	34	44	0	20	0	162	57	23	10	35	179	0	0
1	1016	53	4.32	36	40	0	19	0	171	62	19	12	0	183	0	0
2	462	58	4.10	39	41	0	35	0	172	58	31	16	25	185	0	1
3	1187	53	4.07	38	44	0	20	0	174	68	26	14	25	189	0	0
4	553	54	3.94	37	42	0	24	0	175	66	30	12	0	184	0	0

In [2]:

```
dataset['ID'] = dataset['ID'].astype(object)
```

In [3]:

```
dataset.describe()
```

Out[3]:

	Length	Birthweight	Headcirc	Gestation	smoker	mage	mnocig	mheight	mppwt	fage	fedyrs	fnocig	fheight
count	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.000000	42.00000
mean	51.333333	3.312857	34.595238	39.190476	0.523810	25.547619	9.428571	164.452381	57.500000	28.904762	13.666667	17.190476	180.50000
std	2.935624	0.603895	2.399792	2.643336	0.505487	5.666342	12.511737	6.504041	7.198408	6.863866	2.160247	17.308165	6.97818
min	43.000000	1.920000	30.000000	33.000000	0.000000	18.000000	0.000000	149.000000	45.000000	19.000000	10.000000	0.000000	169.00000
25%	50.000000	2.940000	33.000000	38.000000	0.000000	20.250000	0.000000	161.000000	52.250000	23.000000	12.000000	0.000000	175.25000
50%	52.000000	3.295000	34.000000	39.500000	1.000000	24.000000	4.500000	164.500000	57.000000	29.500000	14.000000	18.500000	180.50000
75%	53.000000	3.647500	36.000000	41.000000	1.000000	29.000000	15.750000	169.500000	62.000000	32.000000	16.000000	25.000000	184.75000
max	58.000000	4.570000	39.000000	45.000000	1.000000	41.000000	50.000000	181.000000	78.000000	46.000000	16.000000	50.000000	200.00000

In [4]:

```
'''
Q1. What is the mean father's age?
'''
fathers = dataset['fage']
mean = fathers.mean()

print(f"Mean is {mean:.3f} years")
```

```
Mean is 28.905 years
```

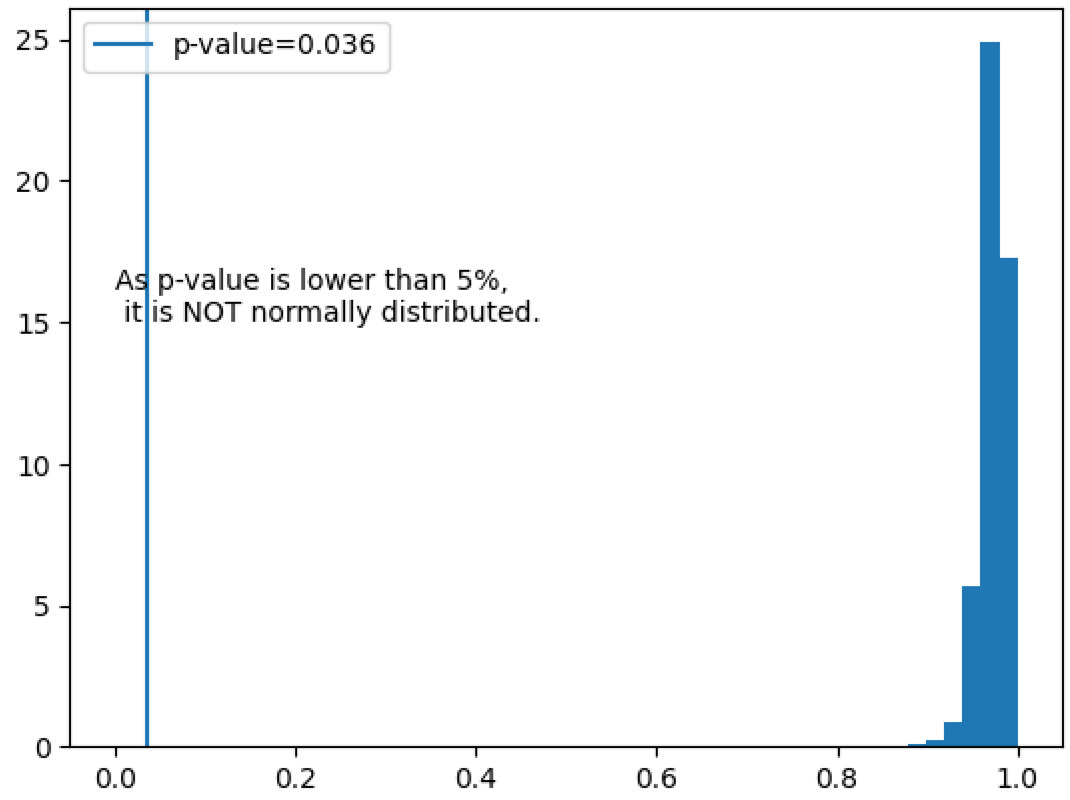
In [5]:

```
'''
Q2. What is the mean father's age for low birthweight babies?
'''
m = dataset[dataset['lowbwt']==1]['fage'].mean()

print(f"Mean is {m:.3f} years")
```

```
Mean is 24.833 years
```

In [6]:

```
'''
Q3. Is the father's age normally distributed? Justify your answer.
'''
shapiro_test(dataset['fage'])
```



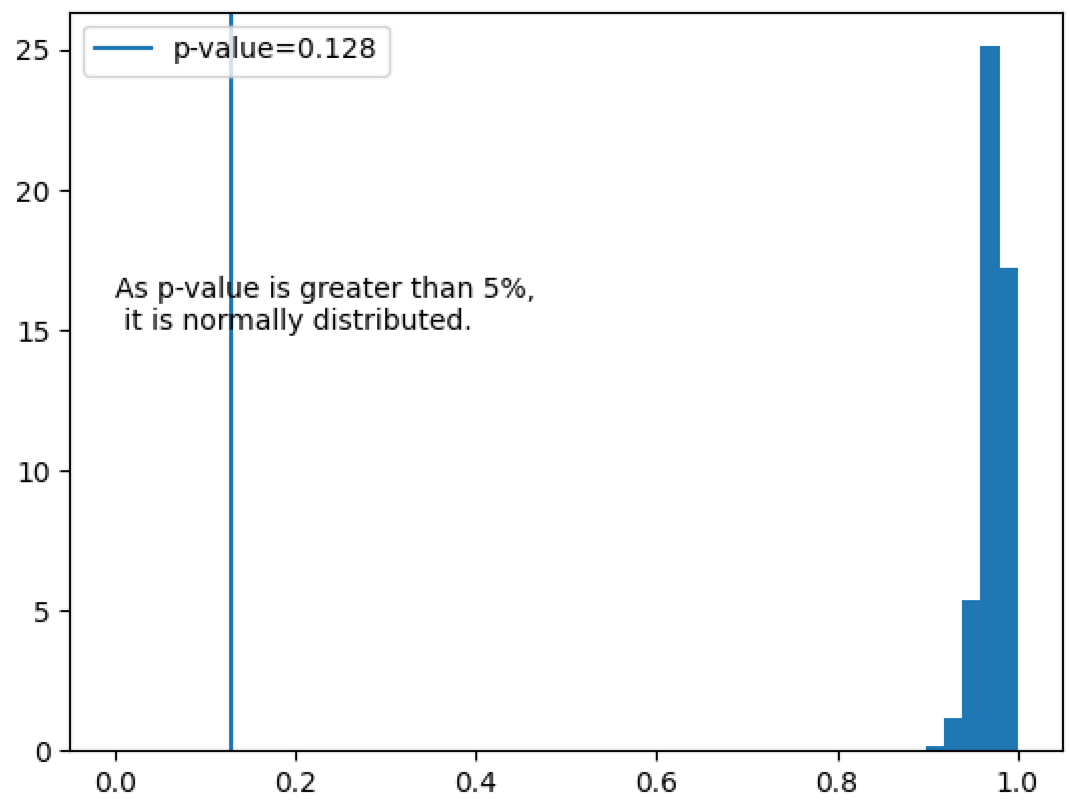
In [7]:
```
'''
Q4. If you apply the log transformation to the father's age, what is the mean score of the transformed variable?
'''
log_strans = np.log(dataset['fage'])
log_strans.mean()
```

Out[7]:
```
np.float64(3.3370421189026085)
```

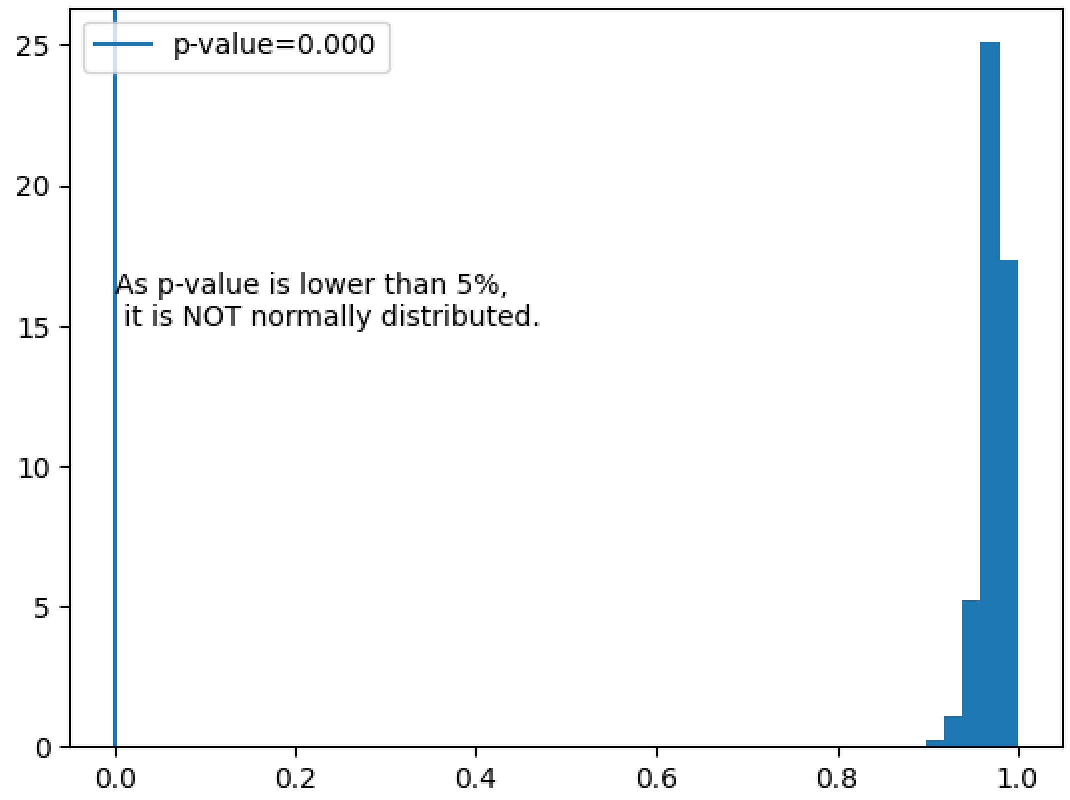
In [8]:
```
'''
Q5. Is the above mean score a good representation of the real value? Justify your answer.
'''
print('''The mean score of the log-transformed variable (3.33) is not a direct
      representation of the real value in the original scale. However,
      it provides valuable information about the distribution and central tendency of the data after transformation.''')
```

```
The mean score of the log-transformed variable (3.33) is not a direct
      representation of the real value in the original scale. However,
      it provides valuable information about the distribution and central tendency of the data after transformation.
```

In [9]:
```
'''
Q6. Is the new variable (log transform of father’s age) normally distributed? Justify your answer.
'''
shapiro_test(np.log(dataset['fage']))
```



In [10]:
```
'''
Q7. Is the variable “years father was in education” normally distributed?
'''
shapiro_test(dataset['fedyrs'])
```



In [11]:
```
'''
Q8. Mentioning the null and alternative hypotheses, explain the above answer.
'''
print('''The Shapiro-Wilk test tests the null hypothesis that the data are drawn from a normal distribution.
Therefore, with a p-value below 0.05, we reject the null hypothesis and conclude that the data are not normally distributed.''')
```

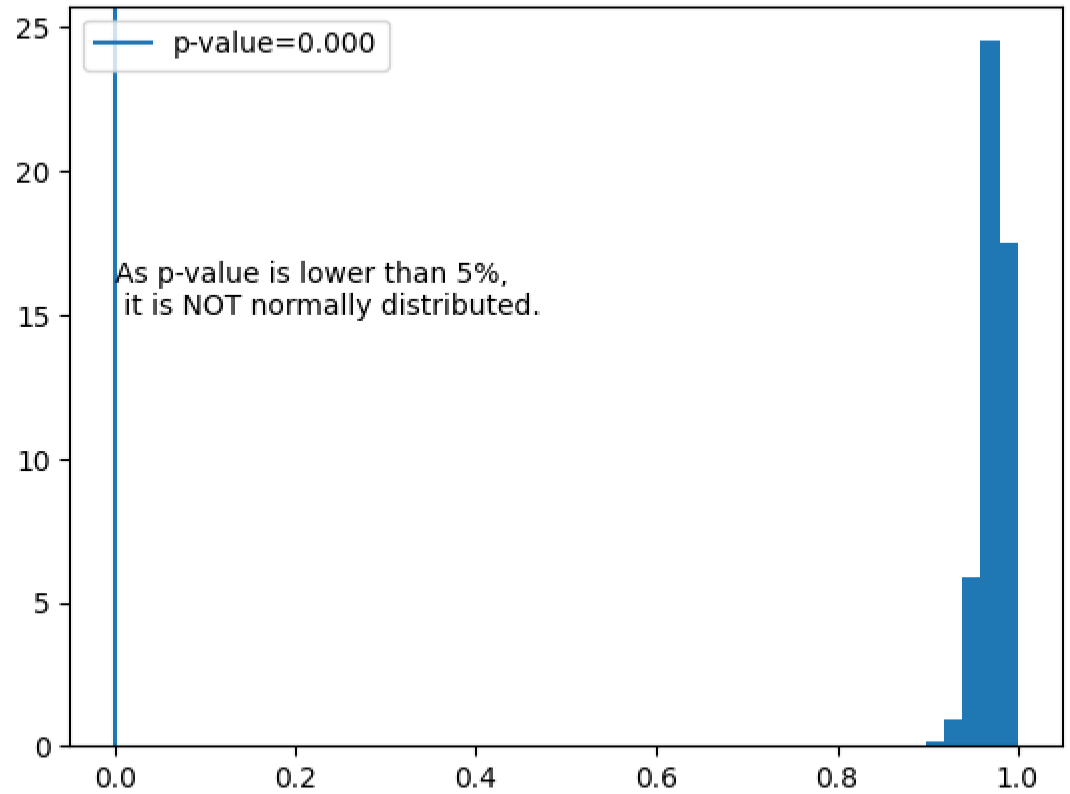
```
The Shapiro-Wilk test tests the null hypothesis that the data are drawn from a normal distribution.
Therefore, with a p-value below 0.05, we reject the null hypothesis and conclude that the data are not normally distributed.
```

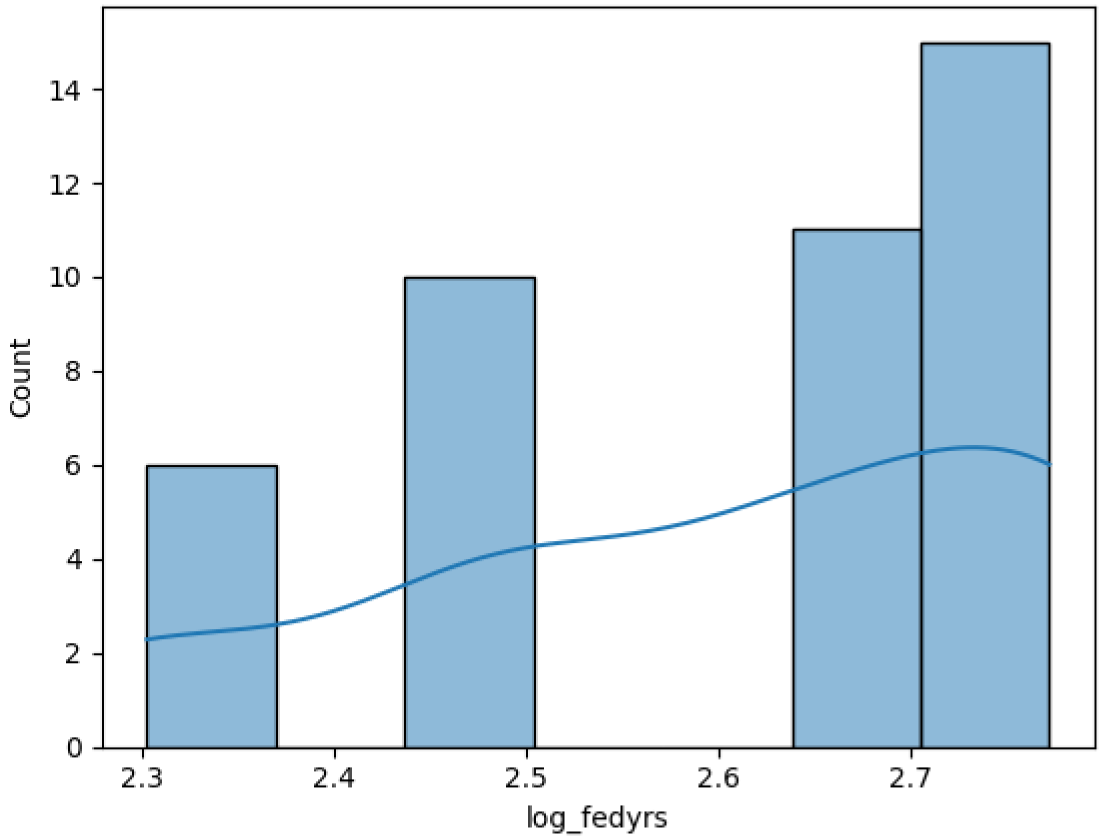
In [12]:
```
'''
Q9. What is the mean score for the variable “years father was in education” after you apply the Box-Cox transformation?
'''
log_trans = np.log(dataset['fedyrs'])
log_trans.mean()
```

Out[12]:
```
np.float64(2.6019771075049722)
```

In [13]:
```
'''
Q10. Is this new variable normally distributed? Explain.
'''

shapiro_test(np.log(dataset['fedyrs']))
dataset['log_fedyrs'] = np.log(dataset['fedyrs'])

fig, ax = plt.subplots()
sns.histplot(dataset, x='log_fedyrs', ax=ax, kde=True)
```

Out[13]:
```
<Axes: xlabel='log_fedyrs', ylabel='Count'>
```



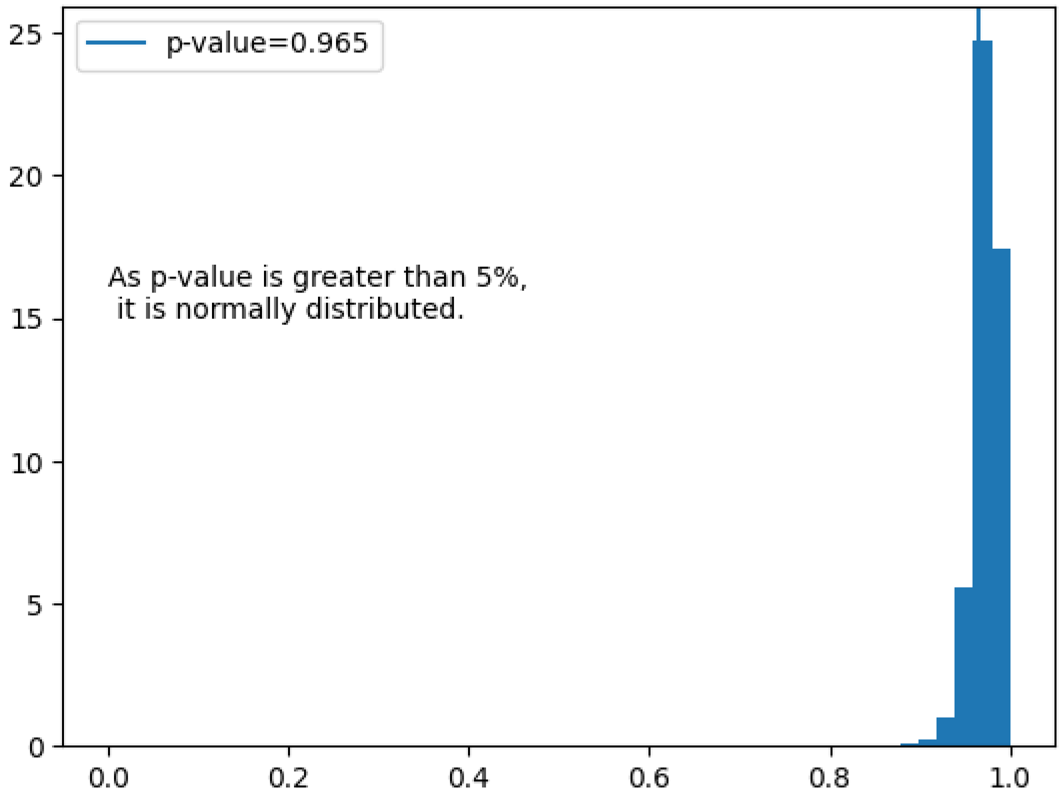


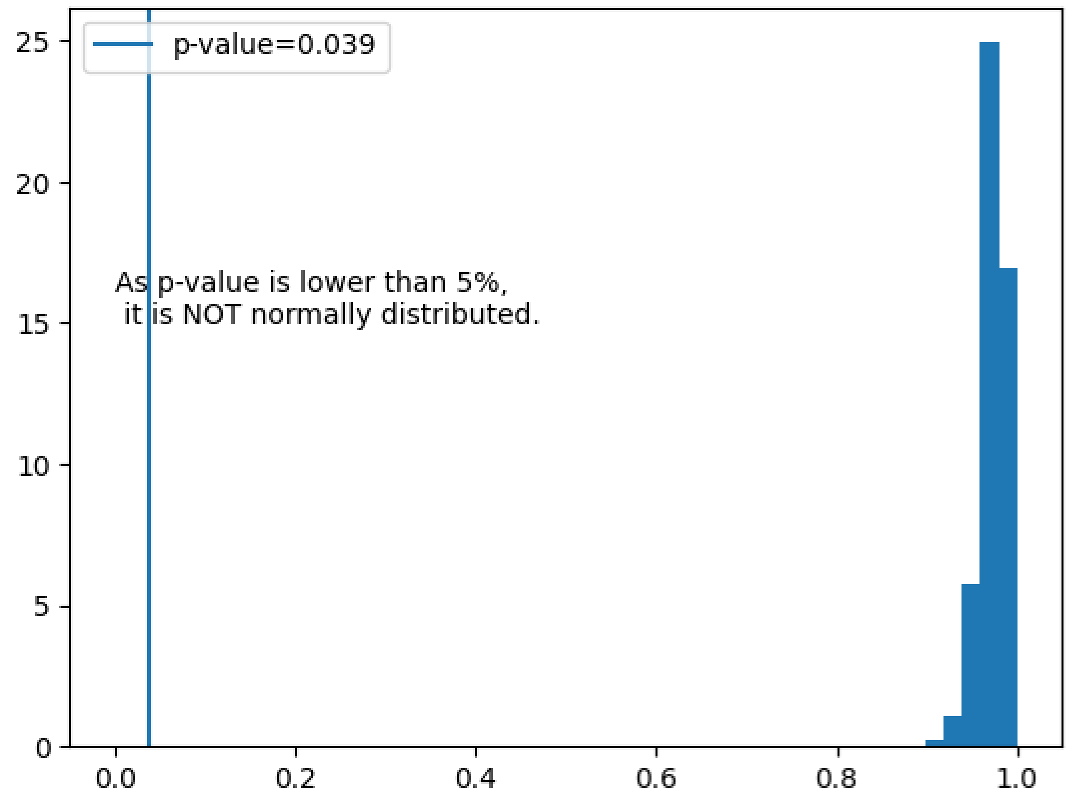
In [14]:
```
'''
Q11. What is the mean score for this new variable (B-C transformed fathers’ years in education) for mothers aged under 35?
'''
m = dataset[dataset['mage35']==0]['log_fedyrs']
print(f'The mean is {m.mean():.3f}')
```

```
The mean is 2.588
```

In [15]:
```
'''
Q12. Which test would you use to investigate the relationship between birth weight and father's age?
'''
shapiro_test(dataset['Birthweight'])
shapiro_test(dataset['fage'])

print("I would use spearman Correlation.")

res = stats.spearmanr(dataset['Birthweight'], dataset['fage'])
print(res.statistic)

res = stats.pearsonr(dataset['Birthweight'], dataset['fage'])
print(res.statistic)
```

```
I would use spearman Correlation.
0.17810631240688332
0.17570999332980183
```



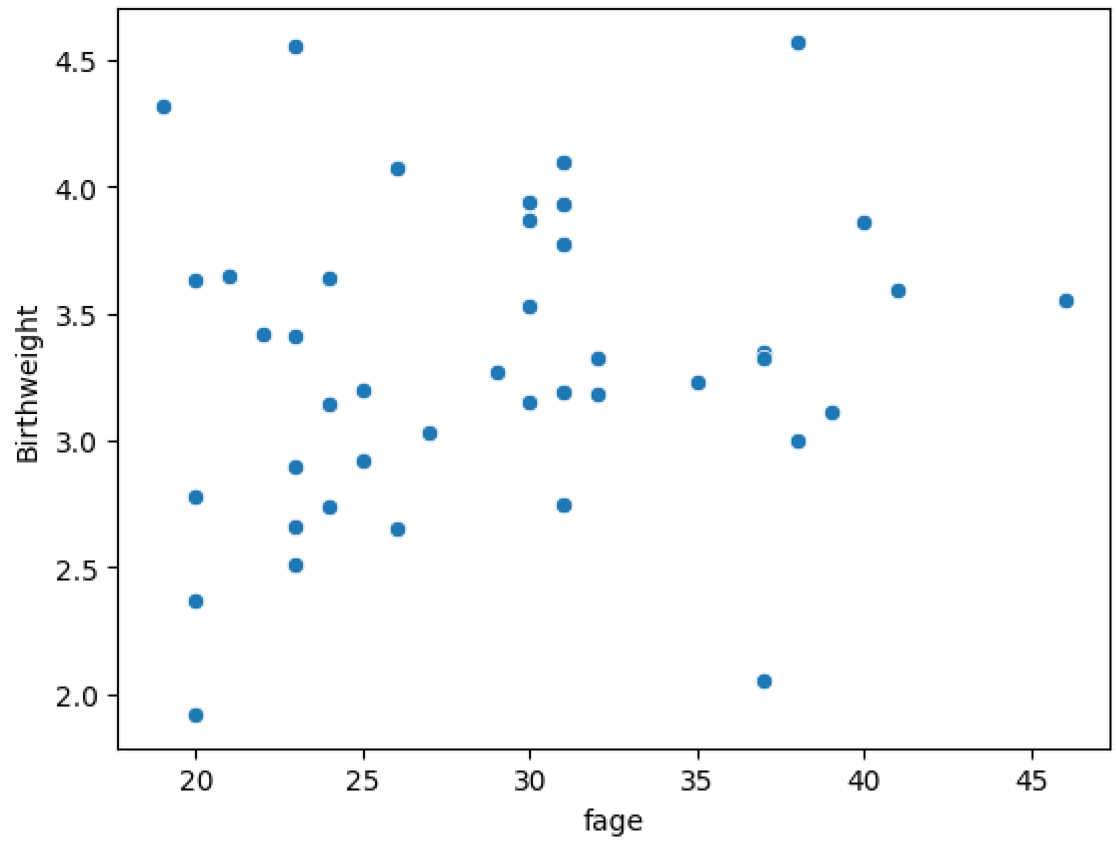


In [16]:
```
'''
Q13. Justify the above choice in terms of the distribution of data and the nature of the test.
'''

print('''
As the data is ordinal but non-normal, it is not possible to use Pearson correlation. Hence, we should stick to the Spearman method.
''')
```

```
As the data is ordinal but non-normal, it is not possible to use Pearson correlation. Hence, we should stick to the Spearman method.
```

In [17]:
```
'''
Q14. What is the direction of that relationship?
Q15. What is the form of that relationship?
Q16. What is the degree of that relationship?
'''
sns.scatterplot(x=dataset['fage'], y=dataset['Birthweight'])
res = stats.spearmanr(dataset['fage'],dataset['Birthweight'])

print(f"The relation is positive (a weak {res.statistic}), but not staticscally significant, as the p-value is greater tha 5%.")
```

```
The relation is positive (a weak 0.17810631240688335), but not staticscally significant, as the p-value is greater tha 5%.
```



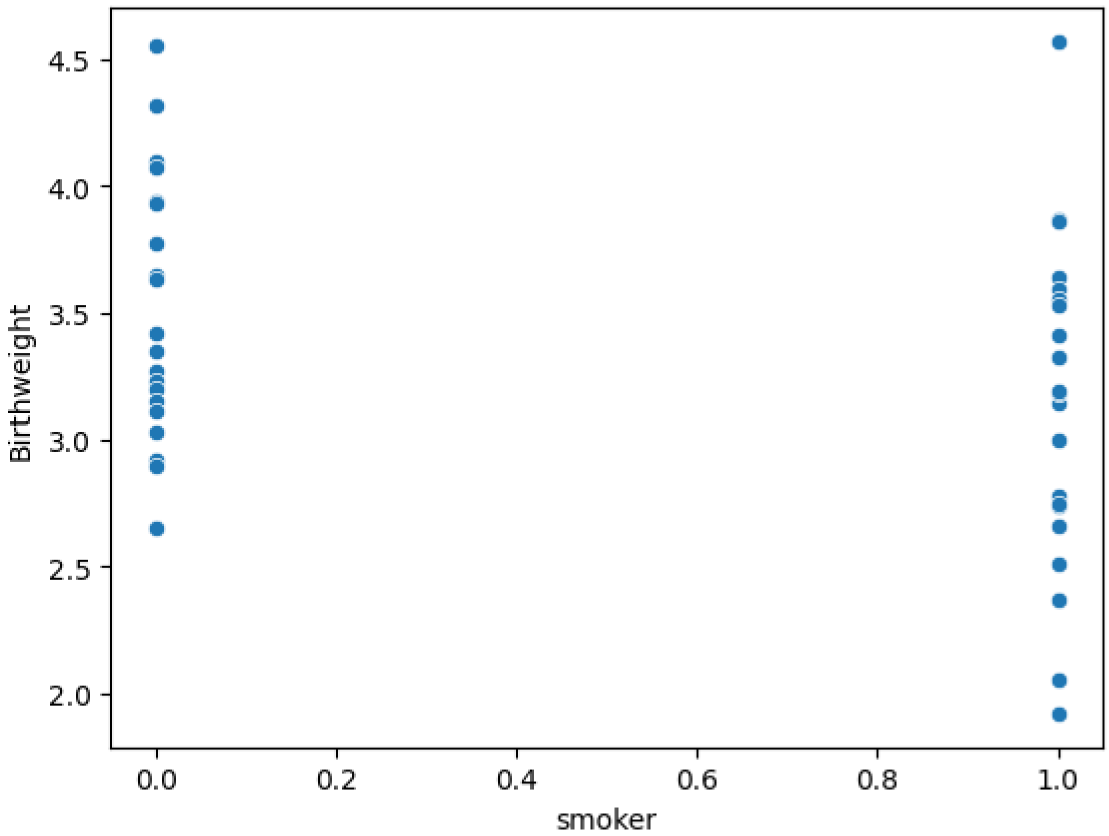
In [18]:
```
'''
Q17. What test would you use to investigate the relationship between smoking and birth weight?
'''
print("I would use point-biserial correlation.")
```

```
I would use point-biserial correlation.
```

In [19]:
```
'''
Q18. Report on the above results including information about direction/form/degree of the relationship.
'''
X = dataset['smoker']
Y = dataset['Birthweight']
res = stats.pointbiserialr(X,Y)

sns.scatterplot(x=X, y=Y)

print(f'''
The results indicate a negative correlation ({res.statistic:.2f}), which is statistically significant (p-value = {res.pvalue:.2f}).
```

```
This result is similar to using Pearson correlation on a dummy-coded smoker variable.
''')

dataset['smoker_dumm'] = pd.get_dummies(dataset['smoker'], drop_first=True)
X_pearson = dataset['smoker_dumm']
stats.pearsonr(X_pearson, Y)

print('''
''')
```

```
The results indicate a negative correlation (-0.31), which is statistically significant (p-value = 0.04).
This result is similar to using Pearson correlation on a dummy-coded smoker variable.
```



In [20]:
```
'''
Q19. If you wanted to see the effect of the length of a baby on birthweight, what would your independent variable be?
'''

print("Length of the baby!")
```

```
Length of the baby!
```

In [21]:
```
'''
Q20. In statistics, when creating a scatterplot, it is a common practice to put the independent variable on the x-axis and the dependent var
 With this in mind, create a scatterplot for the above case and provide the regression line. For homework submitted using MS Word, insert a
'''
fig,ax = plt.subplots(figsize=(5,5))

model = sm.formula.ols('Birthweight ~ Length', data=dataset)
results = model.fit()
dataset['fittedvalues'] = results.fittedvalues
dataset['error'] = results.fittedvalues - dataset['Birthweight']

sns.scatterplot(data=dataset, x="Length", y="Birthweight", ax=ax)
sns.lineplot(data=dataset, x="Length", y="fittedvalues", label='Fitting', ax=ax)
results.summary()
```

Out[21]:

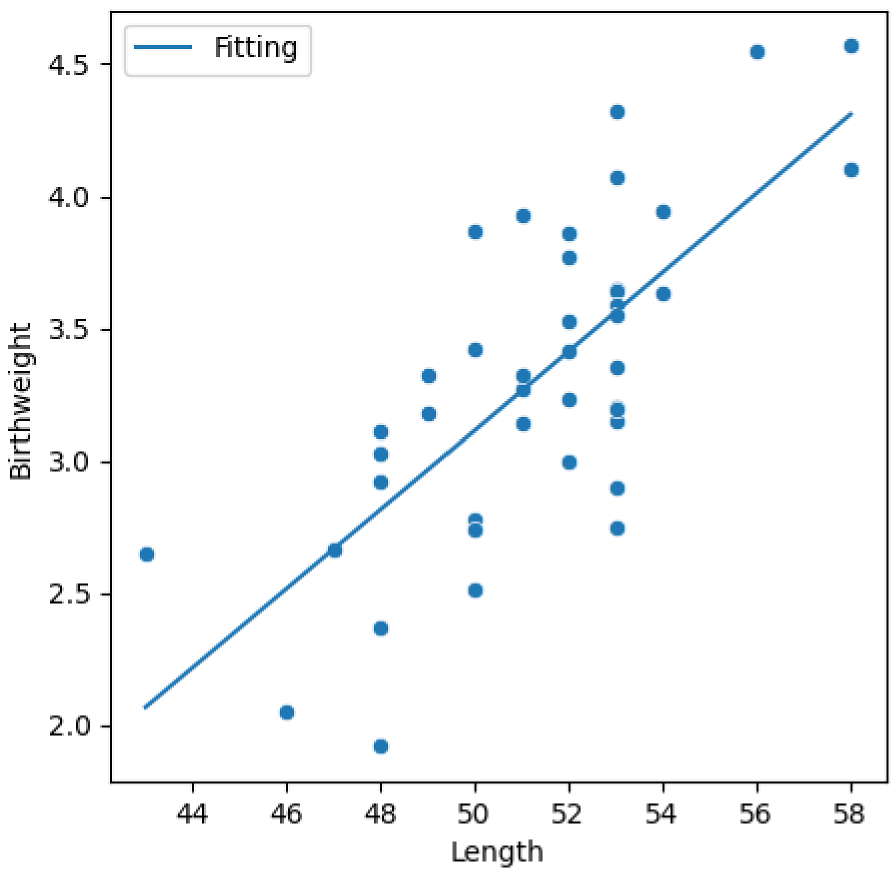
OLS Regression Results

Dep. Variable:	Birthweight	**R-squared:**	0.528
Model:	OLS	**Adj. R-squared:**	0.516
Method:	Least Squares	**F-statistic:**	44.80
Date:	Fri, 01 Nov 2024	**Prob (F-statistic):**	5.03e-08
Time:	14:31:12	**Log-Likelihood:**	-22.127
No. Observations:	42	**AIC:**	48.25
Df Residuals:	40	**BIC:**	51.73
Df Model:	1		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Intercept	-4.3624	1.149	-3.798	0.000	-6.684	-2.041
Length	0.1495	0.022	6.693	0.000	0.104	0.195

Omnibus:	0.686	**Durbin-Watson:**	1.570
Prob(Omnibus):	0.710	**Jarque-Bera (JB):**	0.746
Skew:	-0.126	**Prob(JB):**	0.689
Kurtosis:	2.398	**Cond. No.**	912.

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.



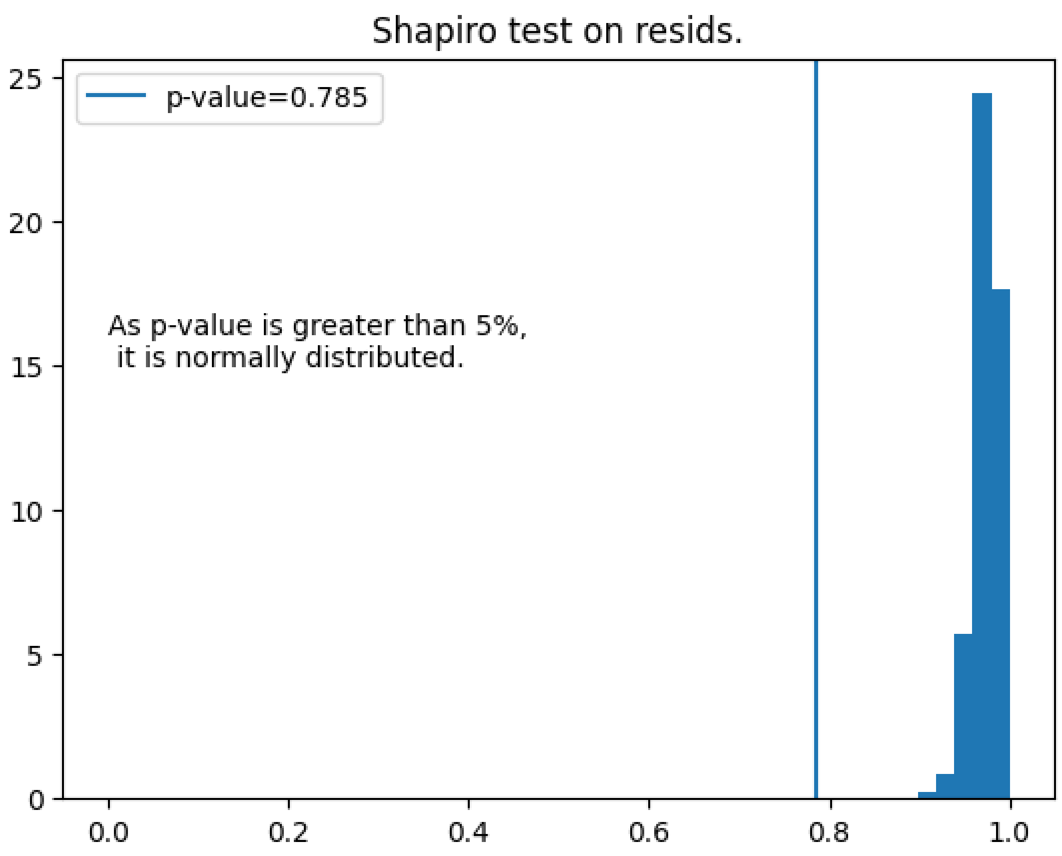
In [22]:
```
'''
Q21. Is the relationship between the length of baby and birthweight linear?
'''
print("Yes.")
```

Yes.

In [23]:
```
'''
Q22. Justify the above choice.
'''
print("The linear regression returned a beta that is statistically significant, and the resids are normally distributed.")
shapiro_test(dataset['error'])
plt.title('Shapiro test on resids.')
```

The linear regression returned a beta that is statistically significant, and the resids are normally distributed.

Out[23]: Text(0.5, 1.0, 'Shapiro test on resids.')

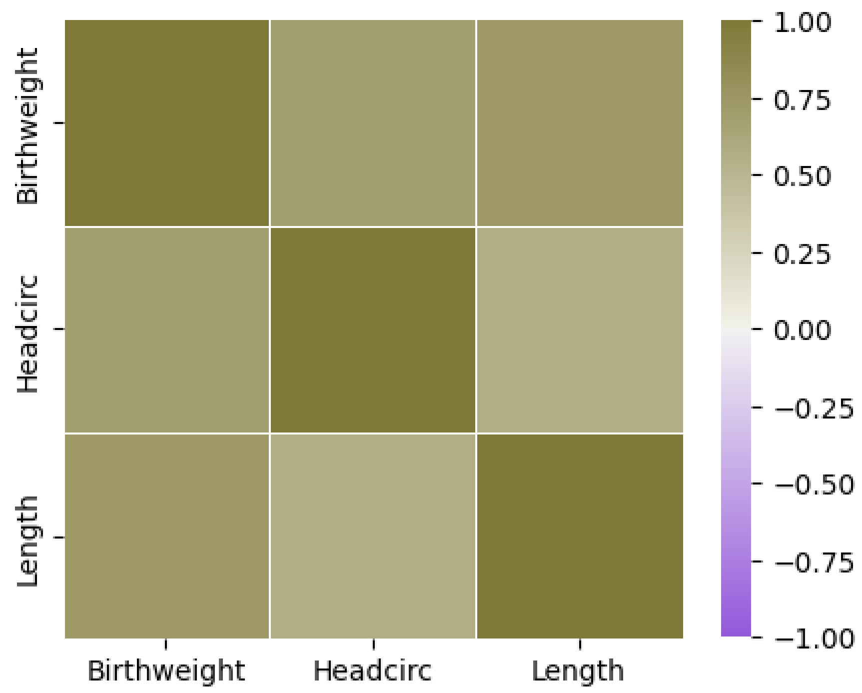


In [56]:
```
'''
Q23 . Is there any evidence to suggest that the birth weight, length of baby, and head circumference are related?
Q24. Justify the above choice.
'''


print("Based on the correlation matrix, there is.")
df = dataset[["Birthweight", "Headcirc", "Length"]]
corr = df.corr()
# Generate a mask for the upper triangle
mask = np.triu(np.ones_like(corr, dtype=bool))

# Set up the matplotlib figure
f, ax = plt.subplots(figsize=(5, 5))

# Generate a custom diverging colormap
cmap = sns.diverging_palette(1000, -1000, as_cmap=True)

# Draw the heatmap with the mask and correct aspect ratio
sns.heatmap(corr, cmap=cmap, vmax=1, center=0, vmin=-1,
            square=True, linewidths=.5, cbar_kws={"shrink": .8})

corr
```

```
Based on the correlation matrix, there is.
```

Out[56]:

	Birthweight	Headcirc	Length
Birthweight	1.000000	0.684616	0.726833
Headcirc	0.684616	1.000000	0.563172
Length	0.726833	0.563172	1.000000



In [57]:
```
'''
Q25. Describe the above relationship in your own words and provide evidence for your claims.
'''

print('''
The relation between head circumference and length of baby is pretty spected, once the human body tends to respect some proportions.
The correlations of Headcirc/Birthweight and Length/Birthweight maybe are also explained by the same aspects.
''')
```

The relation between head circumference and length of baby is pretty spected, once the human body tends to respect some proportions.
The correlations of Headcirc/Birthweight and Length/Birthweight maybe are also explained by the same aspects.