

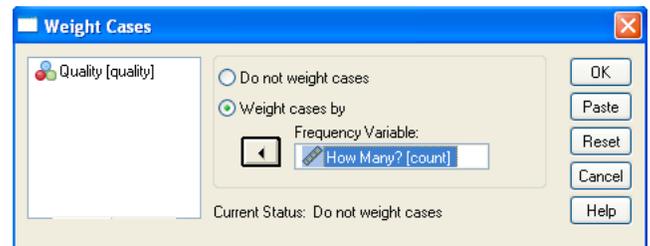
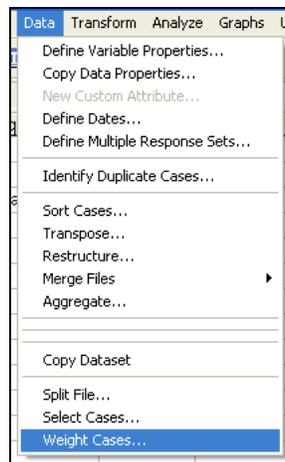
A machine has a record of producing 80% excellent, 17% good, and 3% unacceptable parts. After extensive repairs, a sample of 200 produced 157 excellent, 42 good, and 1 unacceptable part. Have the repairs changed the nature of the output of the machine? Use SPSS with $\alpha = 0.05$.

1. Enter the data into one variable (Quality: 1 = Excellent, 2 = Good, 3 = Unacceptable) so that there are 157 Excellent (1), 42 Good (2), and 1 Unacceptable (3). This method enters raw data.

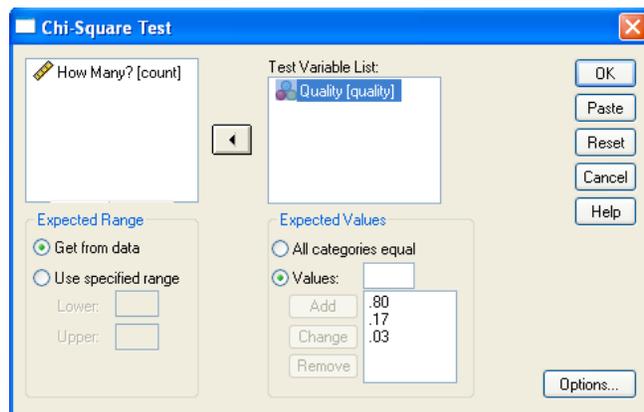
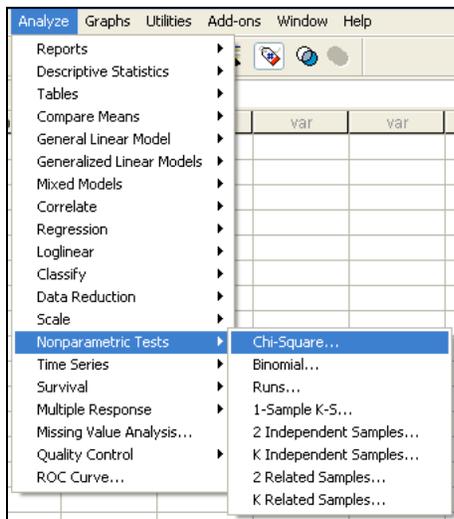
or

Enter the category values into one variable and the observed frequencies into another variable (*see left figure, below*). Then weight the category values variable by the observed frequencies variable (*see two right figures, below*). This method enters tabulated data.

	quality	count
1	Excellent	157
2	Good	42
3	Unacceptable	1



2. Select Analyze → Nonparametric Tests → Chi-Square... (*see left figure, below*).
3. Select “Quality” as the test variable and enter the values for the null hypothesis proportions in numerical order by category value [*i.e.*, $P(\text{Excellent}) = \pi_{1,0} = 0.80$, then $P(\text{Good}) = \pi_{2,0} = 0.17$, then $P(\text{Unacceptable}) = \pi_{3,0} = 0.03$] (*see right figure, below*).



4. Your output gives the expected frequencies table (Step 4.1), the Chi-Square test statistic and p -value (Step 4.3), as well as a footnote for checking the assumptions (Step 4.2).

Chi-Square Test			
Frequencies			
Quality			
	Observed N	Expected N	Residual
Excellent	157	160.0000	-3.0
Good	42	34.0000	8.0
Unacceptable	1	6.0000	-5.0
Total	200		

Test Statistics	
	Quality
Chi-Square ^a	6.1053
df	2
Asymp. Sig.	.0472

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.

Step 1: Hypotheses

H_0 : The repairs did not change the nature of the output of the machine.

[i.e., the proportions remained the same ($\pi_1 = 0.80$, $\pi_2 = 0.17$, $\pi_3 = 0.03$)]

H_a : The repairs did change the nature of the output of the machine.

[i.e., the proportions changed after the repairs (at least one $\pi_i \neq \pi_{i,0}$)]

Step 2: Significance Level

$\alpha = 0.05$

Step 3: Rejection Region

Reject the null hypothesis if $p\text{-value} \leq 0.05 = \alpha$.

Step 4.1: Calculate Expected Frequencies

Quality			
	Observed N	Expected N	Residual
Excellent	157	160.0000	-3.0
Good	42	34.0000	8.0
Unacceptable	1	6.0000	-5.0
Total	200		

Step 4.2: Check Assumptions

According to footnote *a* (below), all expected frequencies are ≥ 5 (smallest value is 6).

Step 4.3: Test Statistic and P-value

Test Statistics	
	Quality
Chi-Square ^a	6.1053
df	2
Asymp. Sig.	.0472

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 6.0.

Step 5: Decision

Since $p\text{-value} = 0.0472 \leq 0.05$, we shall reject the null hypothesis.

Step 6: State conclusion in words

At the $\alpha = 0.05$ level of significance, there is enough evidence to conclude that the repairs changed the nature of the output of the machine (the proportions are not what they used to be).