Example: The following are the final examination of marks of three groups of students who were taught C programming by three different methods.

First Method	94	88	91	74	87	97	
Second Method	85	82	79	84	61	72	80
Third Method	89	67	72	76	69		

Use the Kruskal-Wallis H test at the 5% level of significance to test the hypothesis that the three methods are equally effective.

Solution:

Data

Here,

Dependent variable = marks obtained by the students and

Independent variable = method of teaching C programming (method I, II and III).

So, there are three independent groups.

Hypothesis

Problem here to test is that median scores of the groups of students is same or not.

Le M_1, M_2, and M_3 are the median scores of the group of students who were taught C programming with method I, II and III respectively.

H_0: $M_1 = M_2 = M_3$ (Three methods of teaching are equally effective)

H_1: At least one group has median score different from the rest (At least effect of one group is different from at least one other group)

Test Statistic

The test statistic is given by,

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(n+1)$$

Where,

H = Kruskal-Wallis test statistic

n = Total no. of observations in combined samples = n1 + n2 + … + nk

R_i = Sum of ranks for i^{th} sample

Calculation of test statistics

The combine sample or pooled sample size is $n = n_1 + n_2 + n_3 = 6 + 7 + 5 = 18$

The combined sample is:

94^A 88^A 91^A 74^A 87^A 97^A 85^B 82^B 79^B 84^B 61^B 72^B

80^B 89^C 67^C 72^C 76^C 69^C

Now we have to compute rank value of each score in the sorted list of combined samples.

Sorted Score	Rank	Group	Group A	Group B	Group C
61	1	B	94 (17)	85 (12)	89 (15)
67	2	C	88 (14)	82 (10)	67 (2)
69	3	C	91 (16)	79 (8)	72 (4.5)
72	4.5	B	74 (6)	84 (11)	76 (7)
72	4.5	C	87 (13)	61 (1)	69 (3)
74	6	A	97 (18)	72 (4.5)	
76	7	C		80 (9)	
79	8	B	$n_1 = 6$	$n_2 = 7$	$n_3 = 6$
80	9	B	$R_1 = 84$	$R_2 = 55.5$	$R_3 = 31.5$
82	10	B			
84	11	B			
85	12	B			
87	13	A			
88	14	A			
89	15	C			
91	16	A			
94	17	A			
97	18	A			

Sum of ranks for group I (R_1) = 6 + 13 + 14 + 16 + 17 + 18 = 84

Sum of ranks for group II (R_2) = 1 + 4.5 + 8 + 9 + 10 + 11 + 12 = 55.5

Sum of ranks for group III (R_3) = 2 + 3 + 4.5 + 7 + 15 = 31.5

Now,

$$H = \frac{12}{18(18+1)}\left\{\frac{84^2}{6} + \frac{55.5^2}{7} + \frac{31.5^2}{5}\right\} - 3(18+1) = 6.67$$

Thus, Cal H = 6.67

Correction for H

Number of groups with tied observations = 1

$\sum t$ = (8 – 2) = 6. We have to calculate $\sum t$ for each group which has tied observations. In this case we have only one group which has tied observations i.e. 72 twice.

The correction factor C = $1-\dfrac{6}{(18^3-8)}$ = .99896

Thus,

$$H_C = \frac{H}{C} = \frac{6.67}{0.99896} = 6.677$$

Tabulated value

The tabulated value of H is found by referring to the probability table of chi-square distribution with k-1 = 3 – 1 = 2 degrees of freedom with 5 % area at the right tail.

From table, $\chi^2_{0.05}(2) = 5.991$

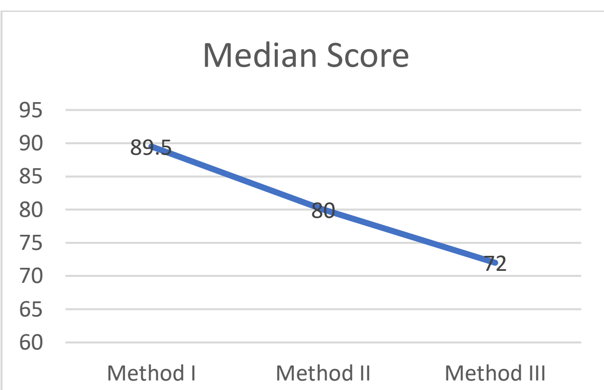
Statistical Decision

Since observed value of H = 6.67 is greater than tabulated value i.e. 5.991, we reject H_0 in favour of H_1.

Conclusion

At least one group has median score different form the rest. To find it we have to calculate median for each group.

Group	**Median Score**	**Remarks**
Method I	89.5	Highest performing group
Method II	80	Average performing group
Method III	72	Lowest performing group



It seems to be groups are different in terms of median score. So three methods of teaching produce different effect and best result is obtained using teaching method I.