Example: Ammonia in Car exhaust. The results of a study of ammonia levels near the exit ramp of a San Francisco highway tunnel are displayed below. The daily ammonia levels are given in ppm on eight randomly selected days during afternoon drive-time. We want to determine whether the median daily ammonia concentration for all afternoon drive-time days exceeds 1.5 ppm.

Observed Ammonia Levels: 1.53 1.50 1.37 1.51 1.55 1.42 1.41 1.48

a. Set up the null and alternative hypotheses for the test.

\[ H_0: \eta = 1.5; \quad H_a: \eta > 1.5 \]

b. Find the value of the test statistic.

\[ S = 3 \quad (\text{Three of the measurements exceed 1.5. Note that one of the measurements is exactly 1.5}) \]

c. Specify the rejection region if \( \alpha = 0.05 \):

Rejection region: Reject \( H_0 \) if \( p\text{-value} < 0.05 \)

d. Find the observed significance level (p-value):

We treat this situation as a binomial experiment where the number of measurements less than 1.5 is treated as a binomial random variable. In the sign test we eliminate observations from the analysis that are exactly equal to the hypothesized median of 1.5. So, in this case the parameters of our binomial distribution should be \( n = 7 \) and \( p = 0.5 \).

\[ p\text{-value} = P( x \geq 3 ) = 1 - P( x \leq 2 ) = 1 - 0.2266 = 0.7734 \]

e. Make the appropriate conclusion (in the words of the example): Since we cannot reject \( H_0 \) at the 0.05 level of significance, we have insufficient evidence to conclude that the median daily ammonia concentration for all drive-time days exceeds 1.5 ppm.

MINITAB output Sign Test for Median

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Sign test of median = 1.500 versus > 1.500

<table>
<thead>
<tr>
<th>PPM</th>
<th>N</th>
<th>Below</th>
<th>Equal</th>
<th>Above</th>
<th>P</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td></td>
<td>0.7734</td>
<td>1.490</td>
</tr>
</tbody>
</table>
```