Statistical evidence of accidents prevention and costs reduction, through alcohol and drug testing at work

- an observational study

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The effect of alcohol and drug testing at the workplace on individual's occupational accident risk

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Paulo Henriques dos Marques, PhD

Prior knowledge derived from literature review

Alcohol and drugs abuse causes risks of accidents

Prior knowledge derived from literature review

Thus, in order to prevent accidents, tests for alcohol and drugs are performed

Prior knowledge derived from literature review

Programmes for testing alcohol and drugs (A&D) at the workplace, at random and by surprise, are believed to have a positive impact on safety and to reduce individual's accident risk

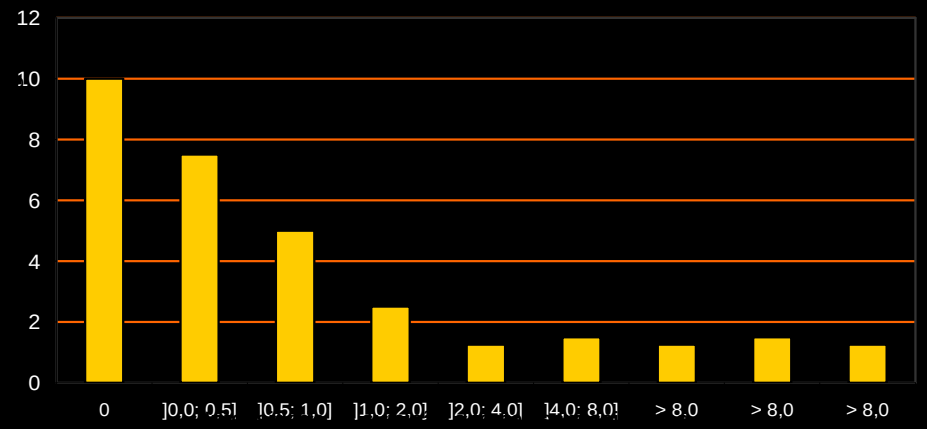
Despite this perception, there is limited scientific evidence and poor statistical support of this assumption

Another issue which has not been properly answered yet - in the rare publications reporting frequency of testing, it still remains to be confirmed the existence of a specific frequency that could be more preventive

Derived research hypotheses

This study aimed at testing whether there is such a cause-effect relationship between A&D testing and post-accident reduction, and how to quantify it

To fill in these gaps, this study raised two hypotheses for research:



H1 (*preventive effect)*:

- The frequency of alcohol and drug testing is negatively associated with the incidence rate of accidents occurred after the tests

H2 *(optimal frequency)*:

- There is an optimal frequency of tests and post-accidents that represents the most efficient frequency, beyond which, increasing the number of annual tests will result in marginal variation of accidents

Methodology

The study design tested whether there is a cause-effect relationship between A&D testing and post-accident reduction, by contrasting the odds of occupational accident risk between workers with different test rates prior to accidents (both exclusively work-related)

A&D tests were applied in the workplace at random and by surprise, for 5½ years, after which, it was found whom had accidents and whom had not after n tests ($n \geq 0$)

Methodology

It covered a wide range of data:

- 29 916 records concerning accidents, A&D tests or the absence of either one or another
- 30 biographical and occupational variables for each of (N = 3 801) ever-present employees of a railway transportation company in Portugal, for a period of 5½ years

Methodology

Homogeneous groups of employees, performing similar tasks and exposed to the same pattern of occupational risks, were studied

Within each occupational group, the experimental stimulus of being (or not) tested for A&D constituted a relevant difference

The portion untested before any accident, which emerged by chance, became the control group within each occupational risks group

[dentro de "Homogeneous groups"]

Group 1 (N1 = 3 801):

- Work onboard trains

Group 2 (N2 = 318):

- Work near or around trains

Group 3 (N3 = 1 583):

- Work away from trains – "white collars"

Methodology

The methodology applied data-mining techniques (CHAID - Chi-square Automatic Interaction Detector) together with classical statistics hypothesis testing:

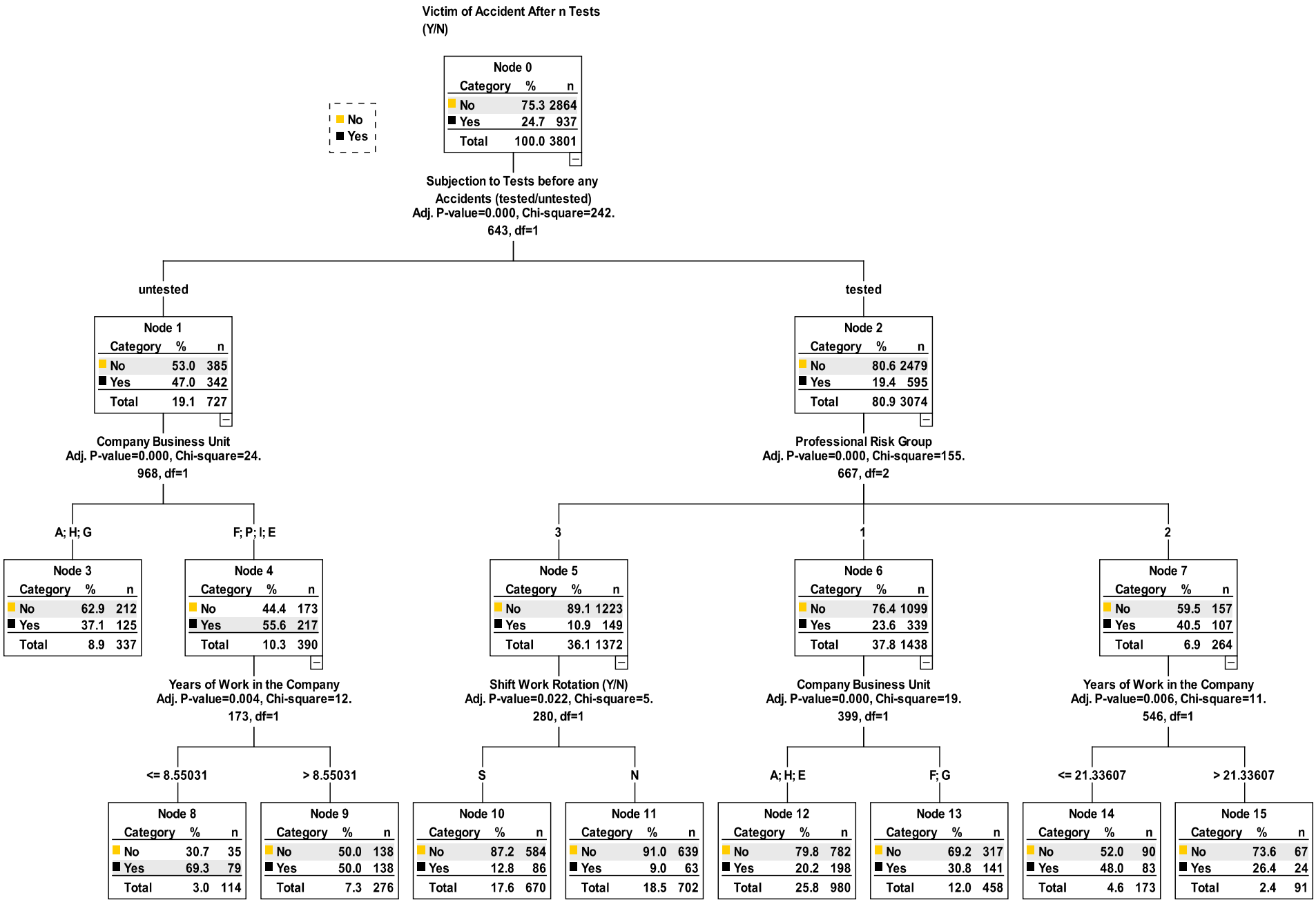
- tests of hypotheses (mean comparisons and analysis of variance)
- Mann-Whitney
- Kolmogorov-Smirnov
- Cramer V
- *Odds ratio*

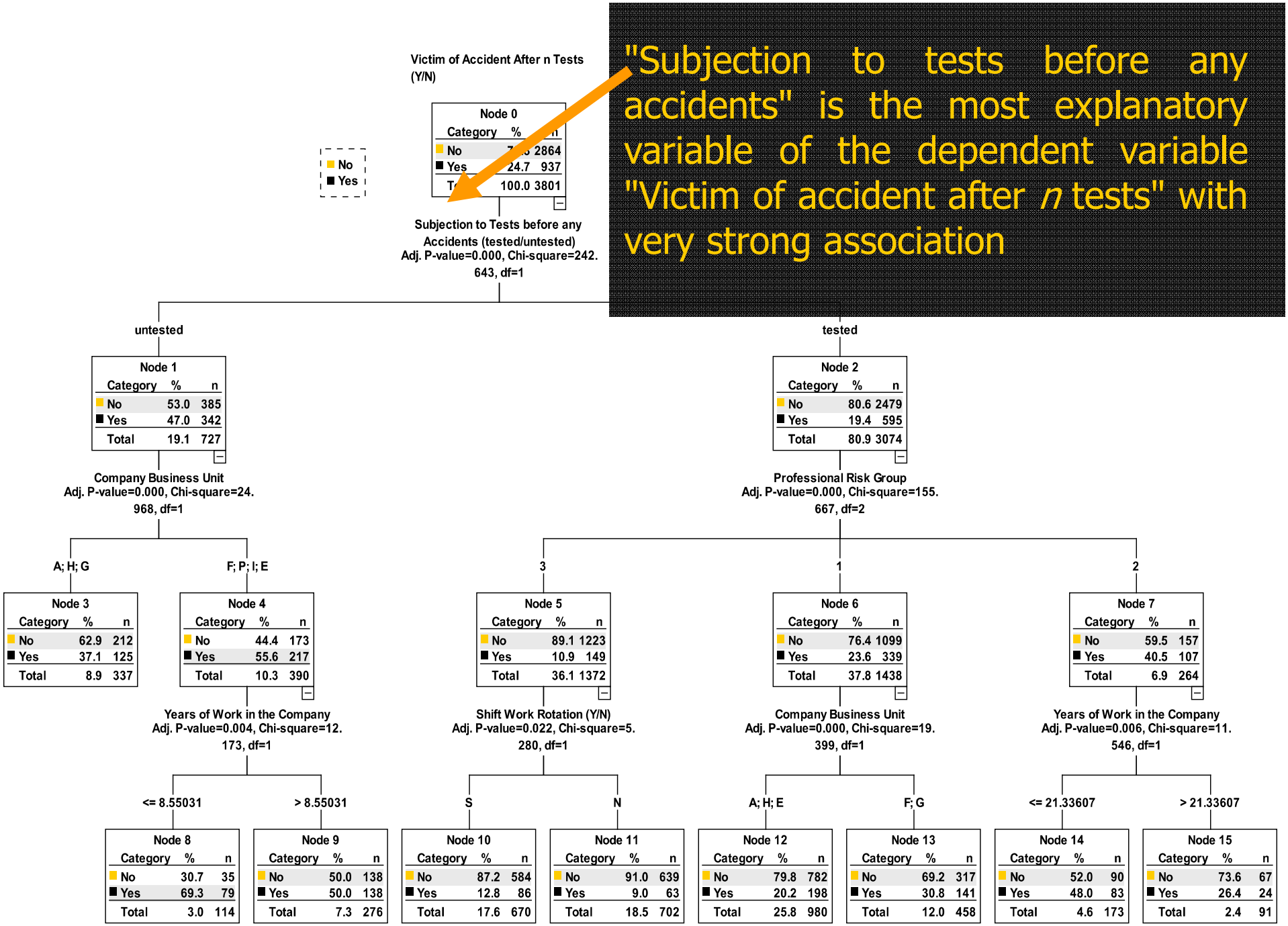
all of which with a significance level of 1%

Results

The CHAID classification trees compared associations between "Victim of accident after *n* tests" and 30 potential explanatory variables, including:

- Age
- Sex
- Academic qualifications
- Marital status
- Underage dependents
- Place of residence
- Tenure
- Medical fitness for work
- Company Business Unit
- Occupational risk group
- Shift work rotation
- Subjection to tests before any accidents
- Annual test frequency before any accidents


Victim of Accident After n Tests (Y/N)
No
Yes
Node 0
Category % n
No 75.3 2864
Yes 24.7 937
Total 100.0 3801
Subjection to Tests before any Accidents (tested/untested)
Adj. P-value=0.000, Chi-square=242.643, df=1
untested
tested
Node 1
Category % n
No 53.0 385
Yes 47.0 342
Total 19.1 727
Node 2
Category % n
No 80.6 2479
Yes 19.4 595
Total 80.9 3074
Company Business Unit
Adj. P-value=0.000, Chi-square=24.968, df=1
Professional Risk Group
Adj. P-value=0.000, Chi-square=155.667, df=2
A; H; G
F; P; I; E
3
1
2
Node 3
Category % n
No 62.9 212
Yes 37.1 125
Total 8.9 337
Node 4
Category % n
No 44.4 173
Yes 55.6 217
Total 10.3 390
Node 5
Category % n
No 89.1 1223
Yes 10.9 149
Total 36.1 1372
Node 6
Category % n
No 76.4 1099
Yes 23.6 339
Total 37.8 1438
Node 7
Category % n
No 59.5 157
Yes 40.5 107
Total 6.9 264
Years of Work in the Company
Adj. P-value=0.004, Chi-square=12.173, df=1
Shift Work Rotation (Y/N)
Adj. P-value=0.022, Chi-square=5.280, df=1
Company Business Unit
Adj. P-value=0.000, Chi-square=19.399, df=1
Years of Work in the Company
Adj. P-value=0.006, Chi-square=11.546, df=1
<= 8.55031
> 8.55031
S
N
A; H; E
F; G
<= 21.33607
> 21.33607
Node 8
Category % n
No 30.7 35
Yes 69.3 79
Total 3.0 114
Node 9
Category % n
No 50.0 138
Yes 50.0 138
Total 7.3 276
Node 10
Category % n
No 87.2 584
Yes 12.8 86
Total 17.6 670
Node 11
Category % n
No 91.0 639
Yes 9.0 63
Total 18.5 702
Node 12
Category % n
No 79.8 782
Yes 20.2 198
Total 25.8 980
Node 13
Category % n
No 69.2 317
Yes 30.8 141
Total 12.0 458
Node 14
Category % n
No 52.0 90
Yes 48.0 83
Total 4.6 173
Node 15
Category % n
No 73.6 67
Yes 26.4 24
Total 2.4 91


"Subjection to tests before any accidents" is the most explanatory variable of the dependent variable "Victim of accident after n tests" with very strong association
Victim of Accident After n Tests (Y/N)
No
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Category % n
No 2864
Yes 24.7 937
100.0 3801
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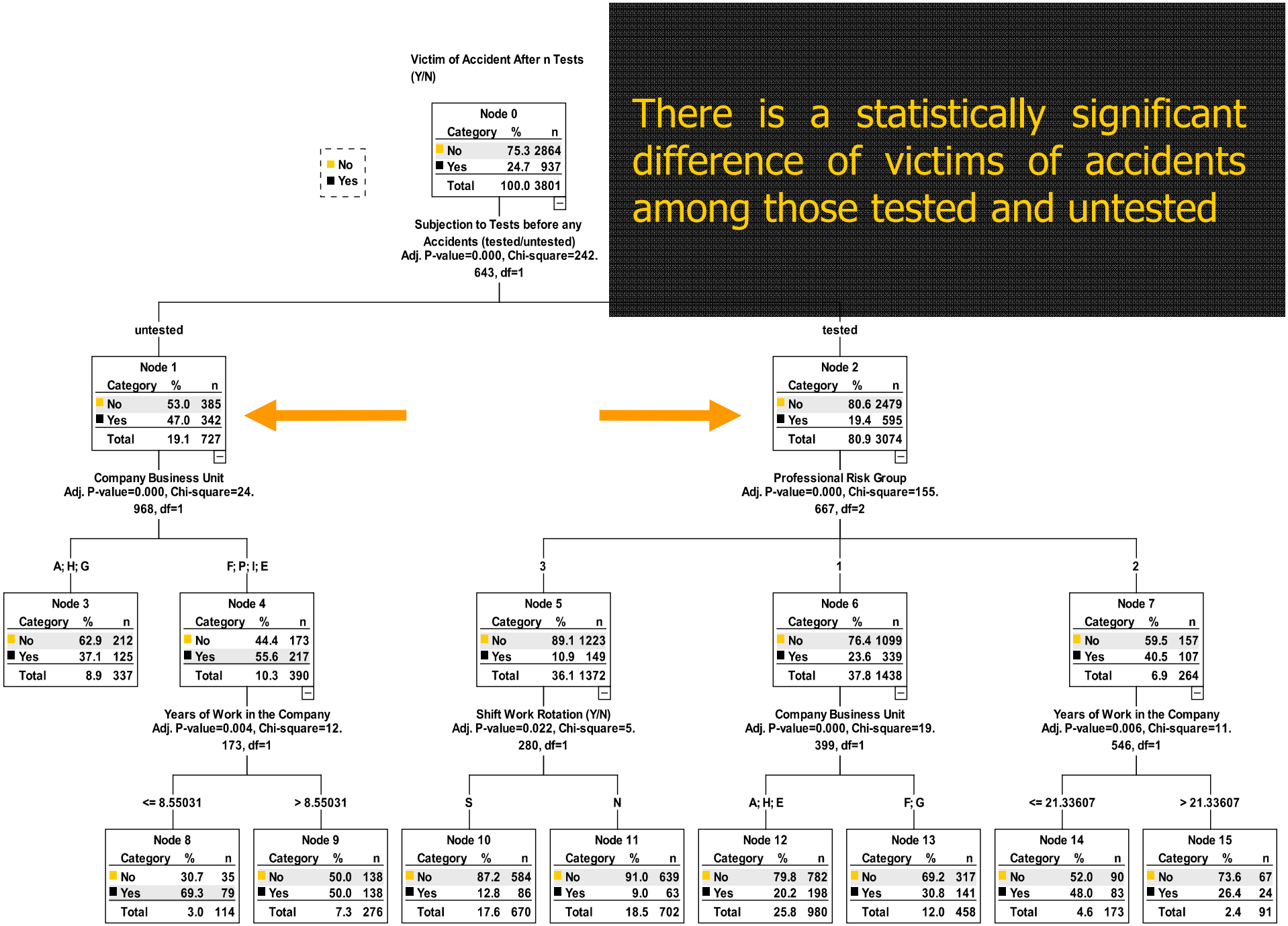
There is a statistically significant difference of victims of accidents among those tested and untested
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Total 100.0 3801
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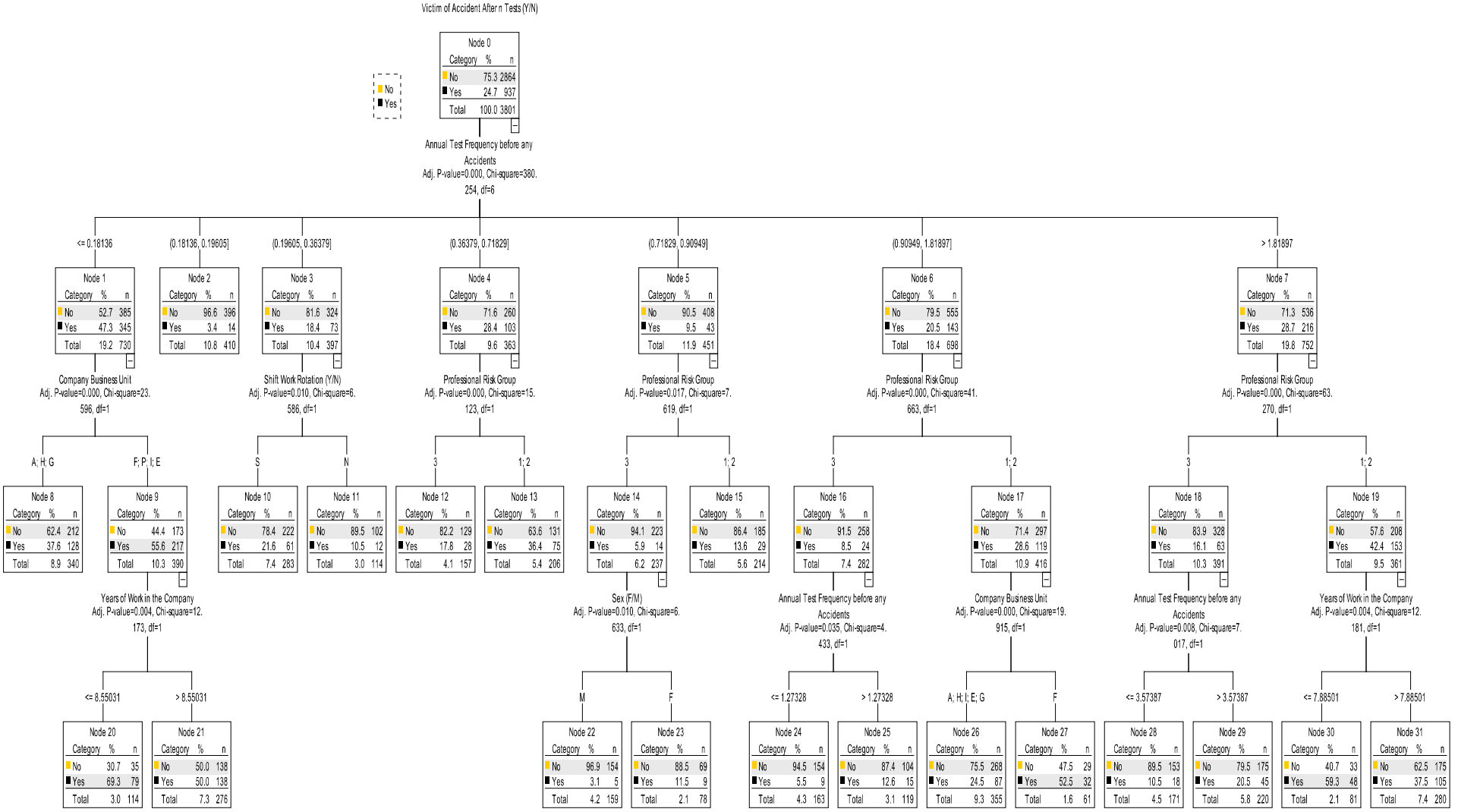
Results

Once the expected negative association between accident occurrence and prior tests was confirmed, this study focused on the annual test frequency and accident rates

When the initial input variable "Subjection to tests" was replaced with the time insensitive variable "Annual test frequency", the same CHAID algorithm showed that this last variable was the first one next to the top of the tree

Again, the testing issue, either expressed only as "tested" and "untested", or expressed in annual frequency, was systematically the most explanatory

[dentro de "showed" no slide anterior]



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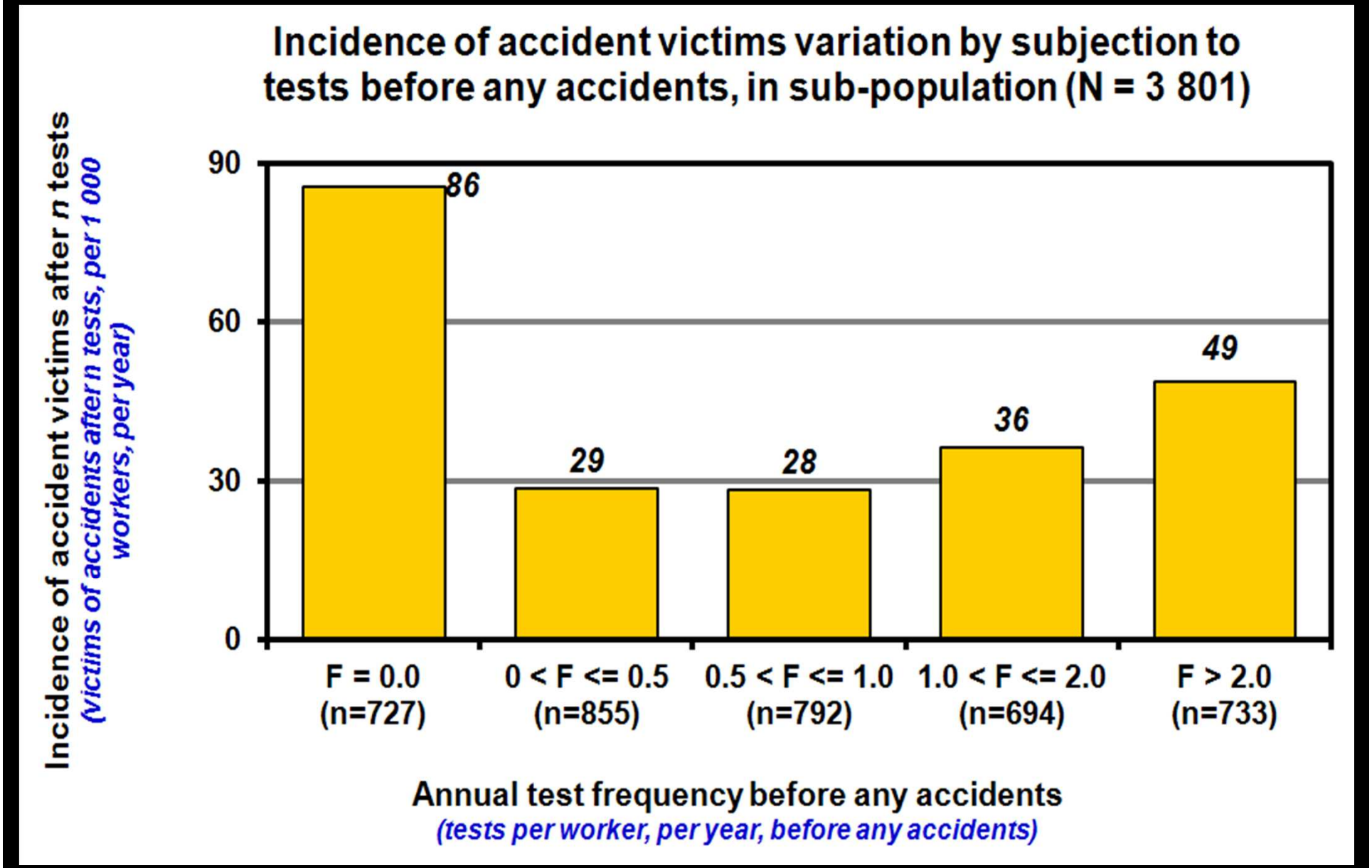
Results

How far an organisation should go in terms of testing effort?

The interest was to find out the optimal frequency, above which there is no benefit in increasing testing, *i.e.*, the frequency of tests at which the accident rates are minimised

[dentro de "optimal" no slide anterior]



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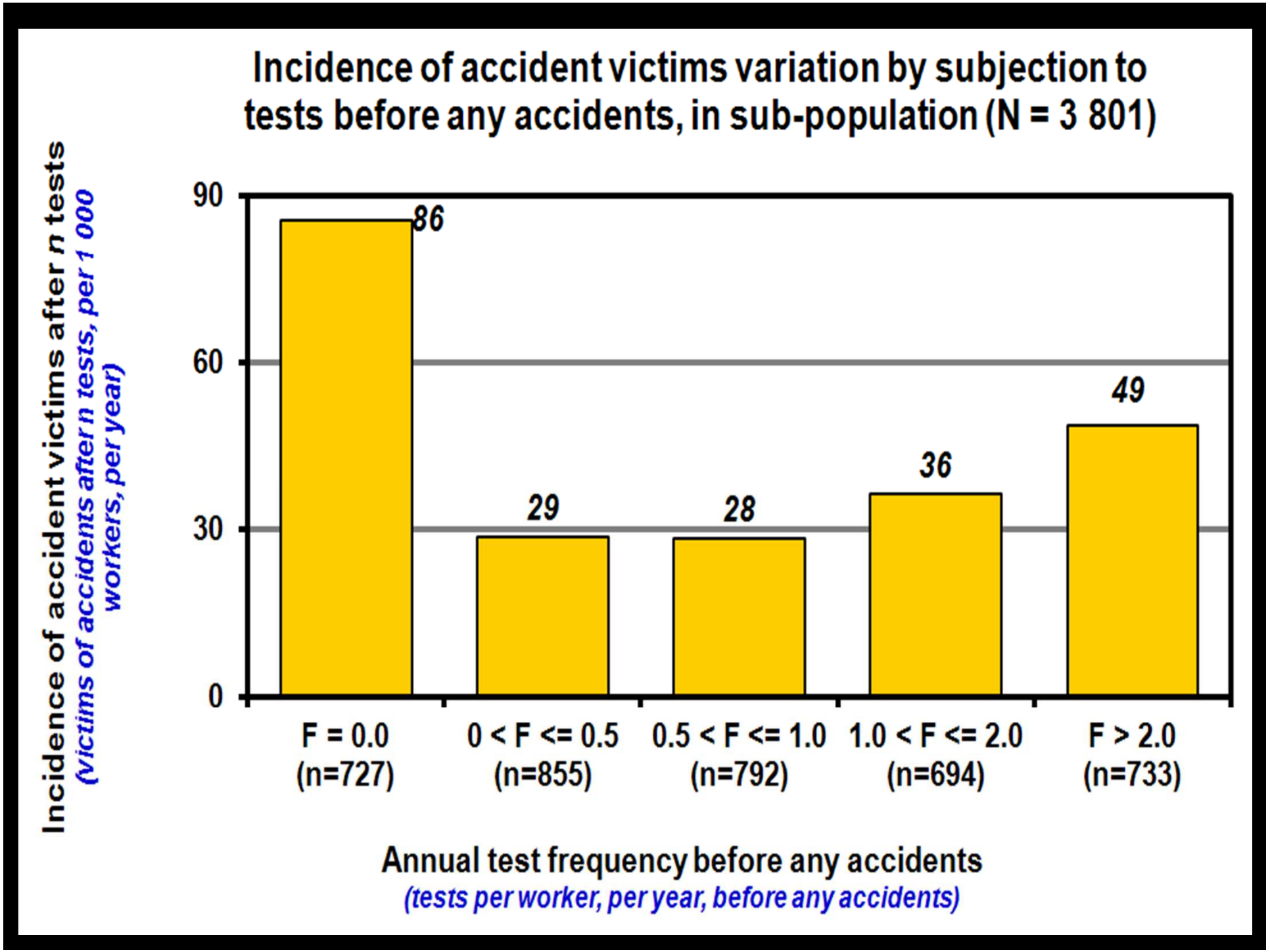
For generality of employees:

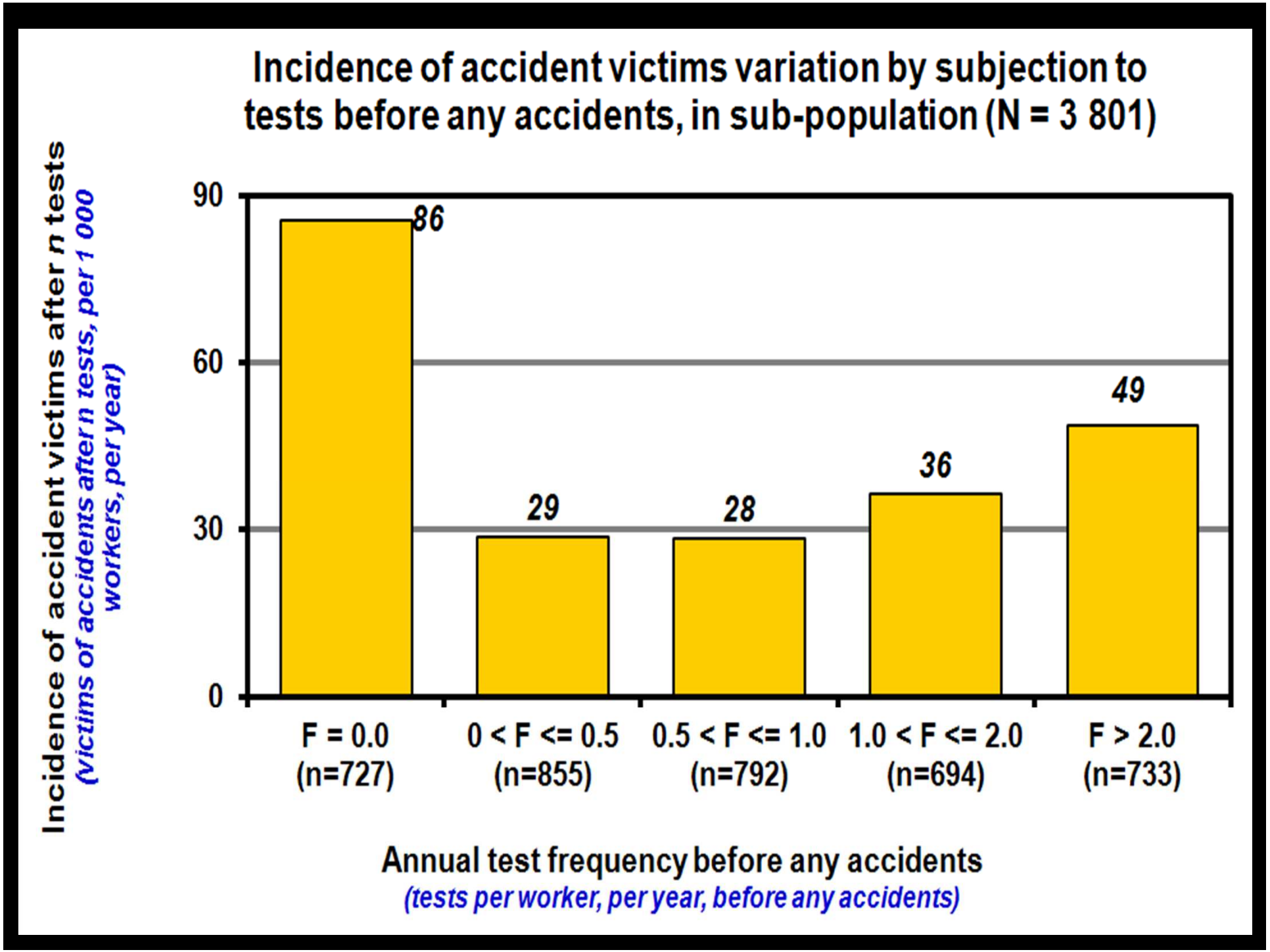
- groups tested for A&D, reported lower accident rates, after any number of tests, than the untested group


Incidence of accident victims variation by subjection to tests before any accidents, in sub-population (N = 3 801)
Incidence of accident victims after n tests
(victims of accidents after n tests, per 1 000 workers, per year)
90
60
30
0
86
29
28
36
49
F = 0.0 (n=727)
0 < F <= 0.5 (n=855)
0.5 < F <= 1.0 (n=792)
1.0 < F <= 2.0 (n=694)
F > 2.0 (n=733)
Annual test frequency before any accidents
(tests per worker, per year, before any accidents)

[dentro da coluna menor (28) no slide anterior]

For generality of employees:

- there is an optimal frequency of testing associated with a minimum accident rate, above which the increase in testing becomes less efficient in terms of prevention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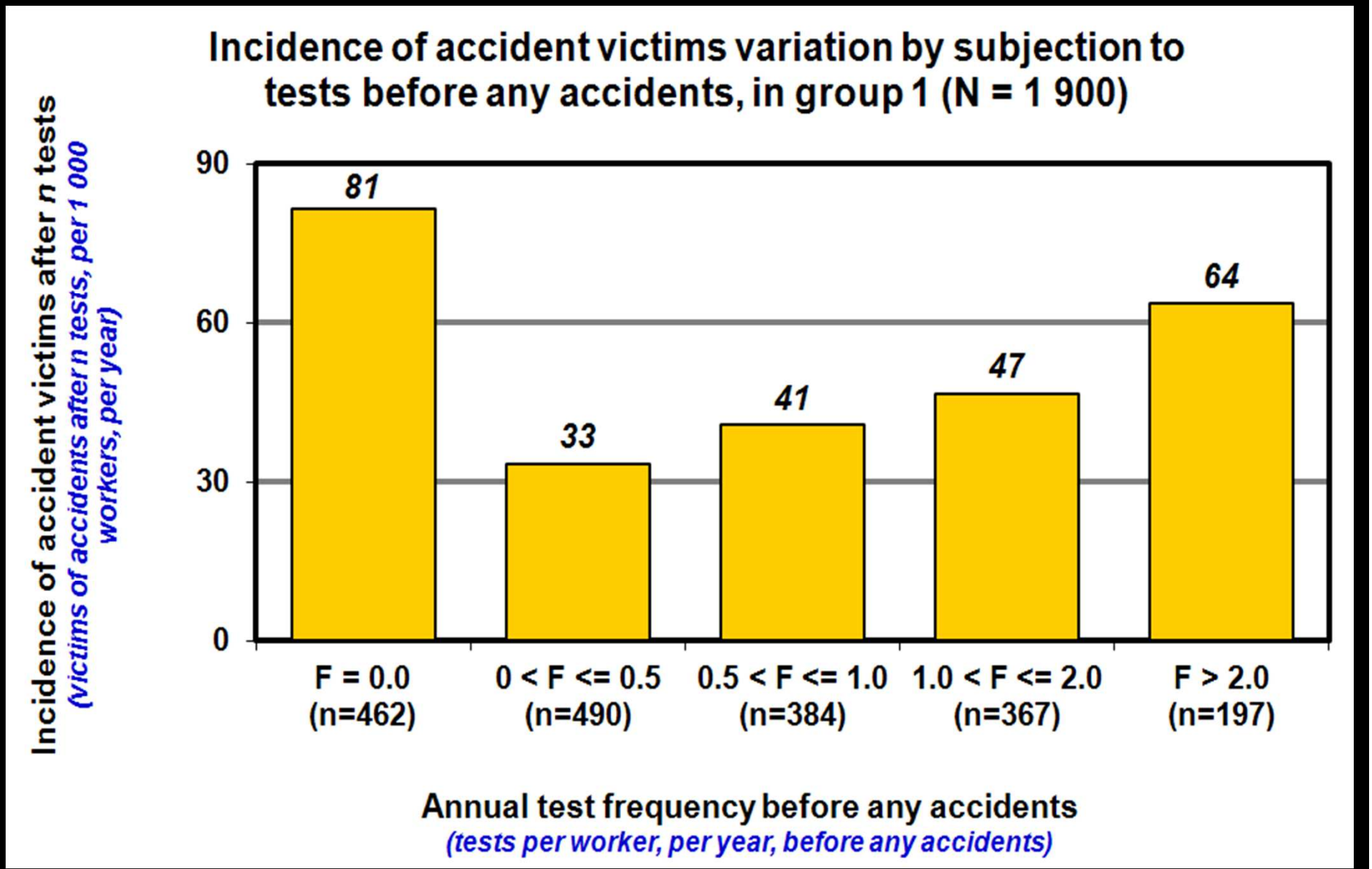
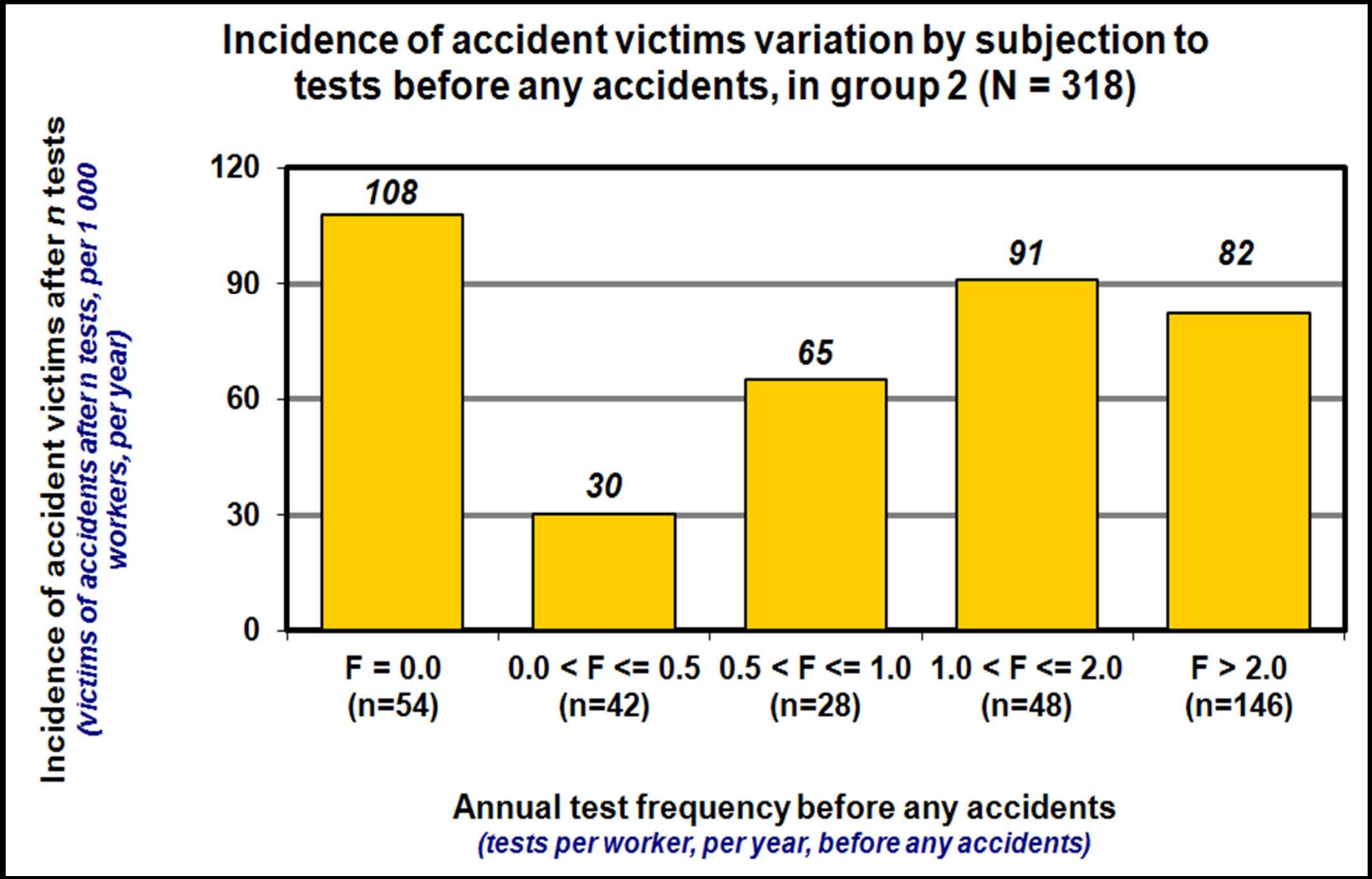
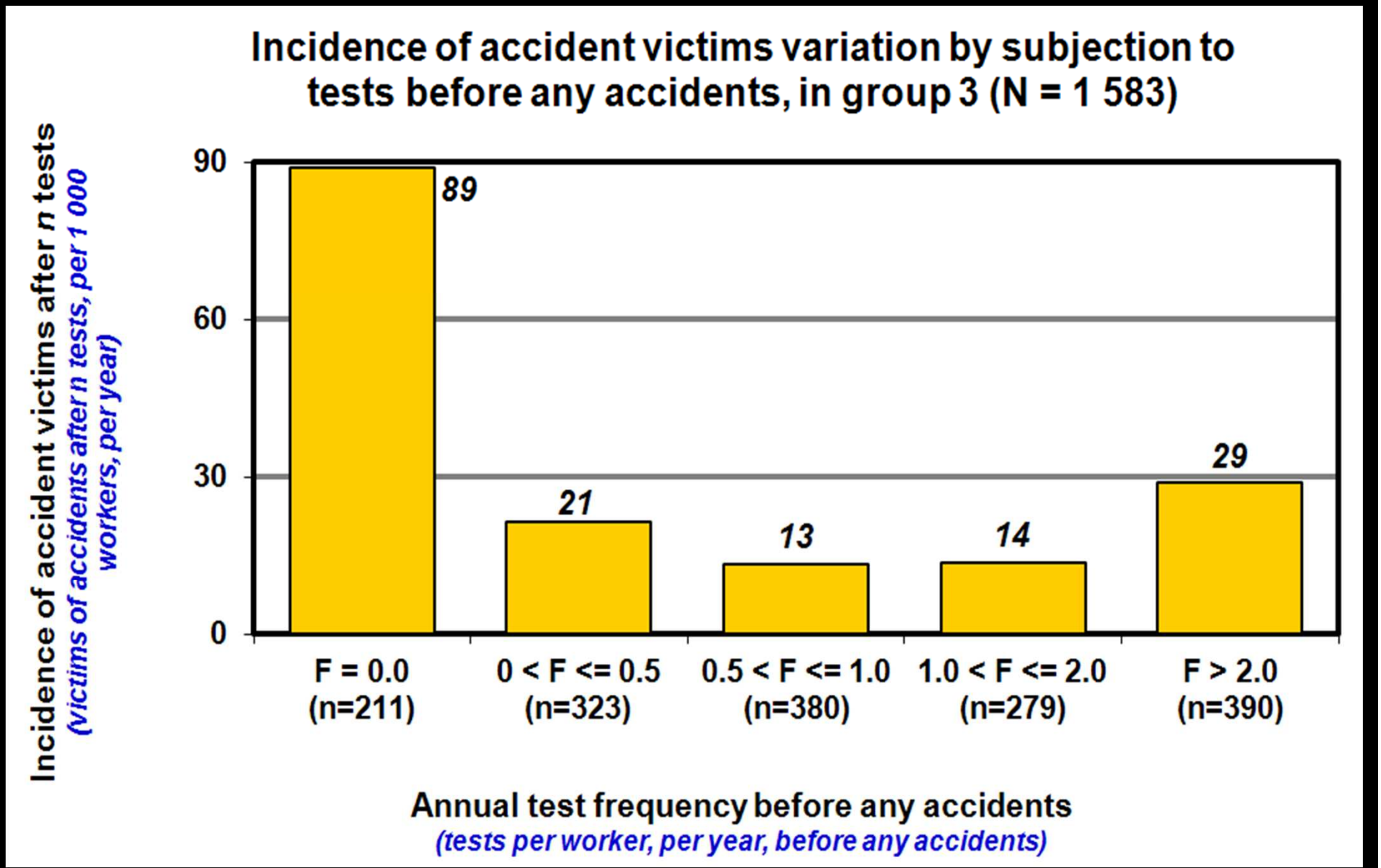
Results


Incidence of accident victims variation by subjection to tests before any accidents, in group 1 (N = 1 900)
Incidence of accident victims after n tests
(victims of accidents after n tests, per 1 000 workers, per year)
90
60
30
0
81
33
41
47
64
F = 0.0 (n=462)
0 < F <= 0.5 (n=490)
0.5 < F <= 1.0 (n=384)
1.0 < F <= 2.0 (n=367)
F > 2.0 (n=197)
Annual test frequency before any accidents
(tests per worker, per year, before any accidents)

Results


Incidence of accident victims variation by subjection to tests before any accidents, in group 2 (N = 318)
Incidence of accident victims after n tests
(victims of accidents after n tests, per 1 000 workers, per year)
120
90
60
30
0
108
30
65
91
82
F = 0.0 (n=54)
0.0 < F <= 0.5 (n=42)
0.5 < F <= 1.0 (n=28)
1.0 < F <= 2.0 (n=48)
F > 2.0 (n=146)
Annual test frequency before any accidents
(tests per worker, per year, before any accidents)

Results


Incidence of accident victims variation by subjection to tests before any accidents, in group 3 (N = 1 583)
Incidence of accident victims after n tests
(victims of accidents after n tests, per 1 000 workers, per year)
90
60
30
0
89
21
13
14
29
F = 0.0 (n=211)
0 < F <= 0.5 (n=323)
0.5 < F <= 1.0 (n=380)
1.0 < F <= 2.0 (n=279)
F > 2.0 (n=390)
Annual test frequency before any accidents
(tests per worker, per year, before any accidents)

Results

The results indicate how much more probable is having an accident if untested compared to tested, as being:

- 3.7 times more, in the sub-population
- 2.6 times more, in group 1
- 2.1 times more, in group 2
- 7.8 times more, in group 3

The individual's accident risk decreases after being tested

Results

Optimal testing frequencies that balance testing costs and accident reduction are in the range:

-]0.5-1.0] tests per year per worker, in white-collars and professions at large
-]0.0-0.5] tests per year per worker, in operations/technical personnel

Results

The fraction of accident victims that are prevented by the application of optimal frequencies are around:

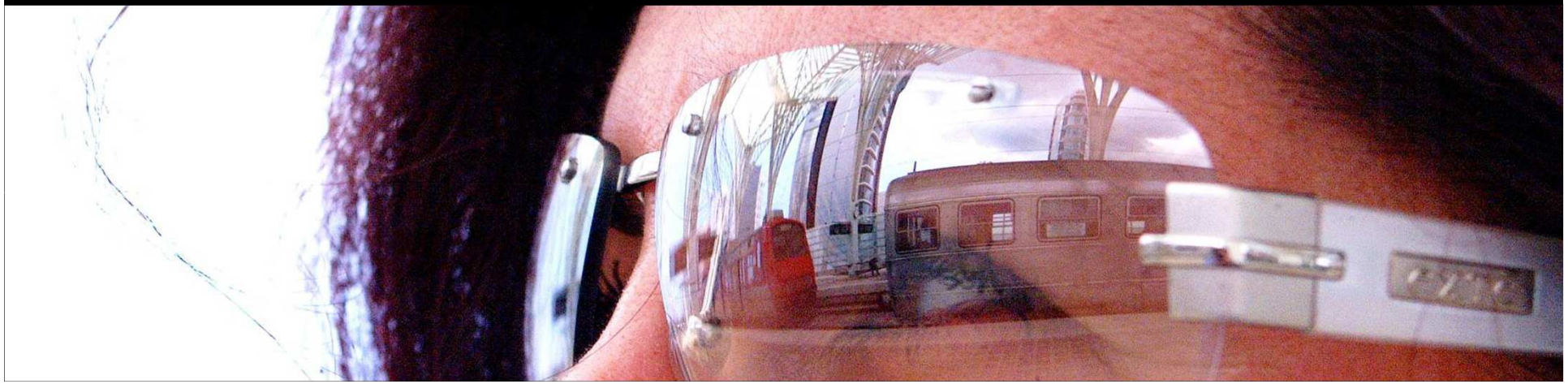
- 59% for workers onboard trains
- 72% for those working near trains
- 85% for white-collars

Results

The average costs with application of tests in group of onboard personnel were compared against the money saved from the non-expenditure with overtime work, due to the reduction of accidents occurred after subjection to tests at the optimal frequency

This showed a net saving of about 15 € for each 1 € invested in testing

Conclusions



Conclusions

- Testing for alcohol and drugs at work, has preventive effect in overall professions, stronger in white-collars
- Each occupational group has an optimal testing frequency associated with a minimum accident rate
- Testing personnel onboard trains at the optimal frequency generates net savings of at least 15:1

These conclusions emerged from the contrast of accident rates after tests, between homogeneous groups of workers, only differing on their test frequency. Thus, all other things being equal, the different individual frequencies of subjection to testing were likely to be responsible for different outcomes

Thank you for your attention

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