Supplemental Material S1: Google Survey Responses

Dear Colleagues,

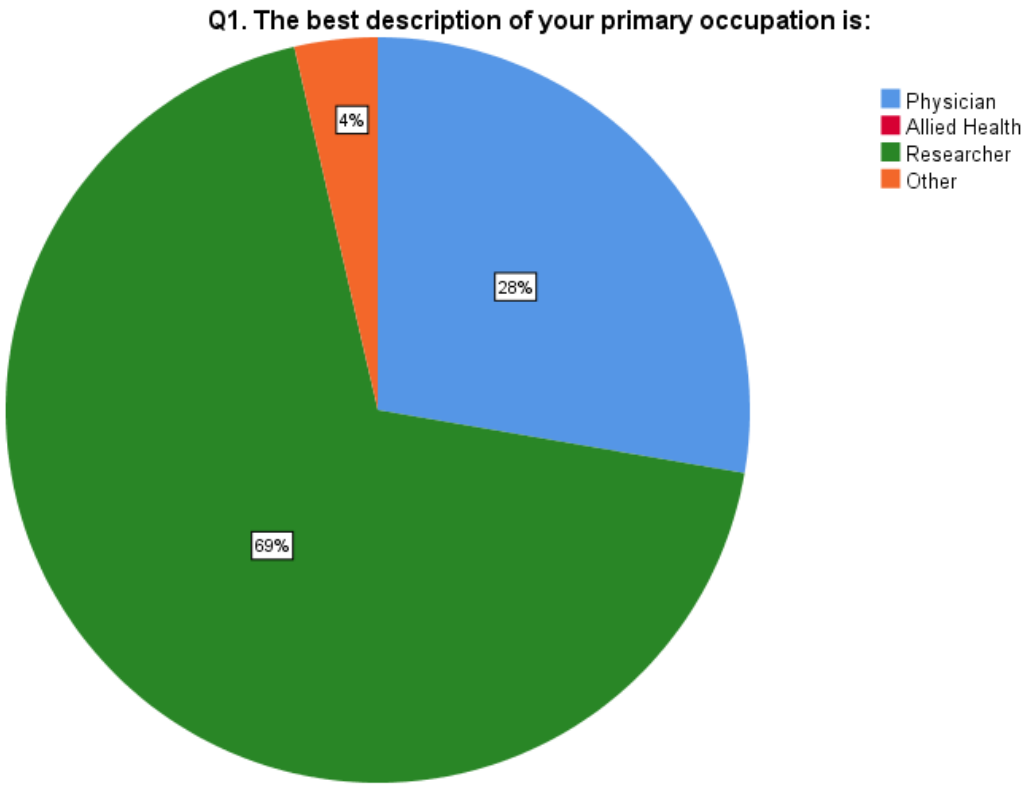
We would like to invite you to complete the following survey that will be used to determine the current consensus on spine biomechanical testing across the international spine research community. Your responses will be summarized in an issue of JOR Spine and we hope that you are able to contribute your valuable expertise to this important consensus paper. The survey is anonymous, however, if you would like your name and affiliation listed as a contributor to the survey then you can include your details after the final question.

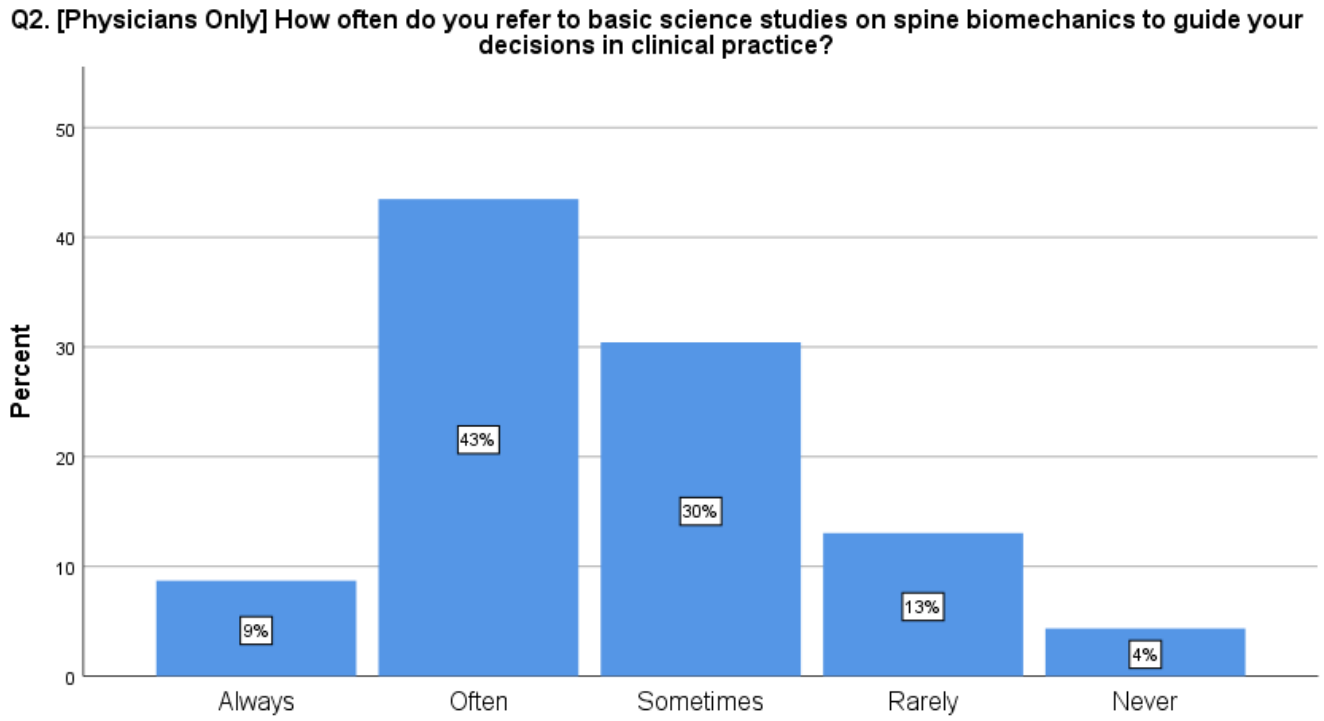
Thank you for your important contribution towards improving the quality of scientific research on spine segment biomechanics.

Kind regards,

John Costi
Grace O'Connell
Eric Ledet

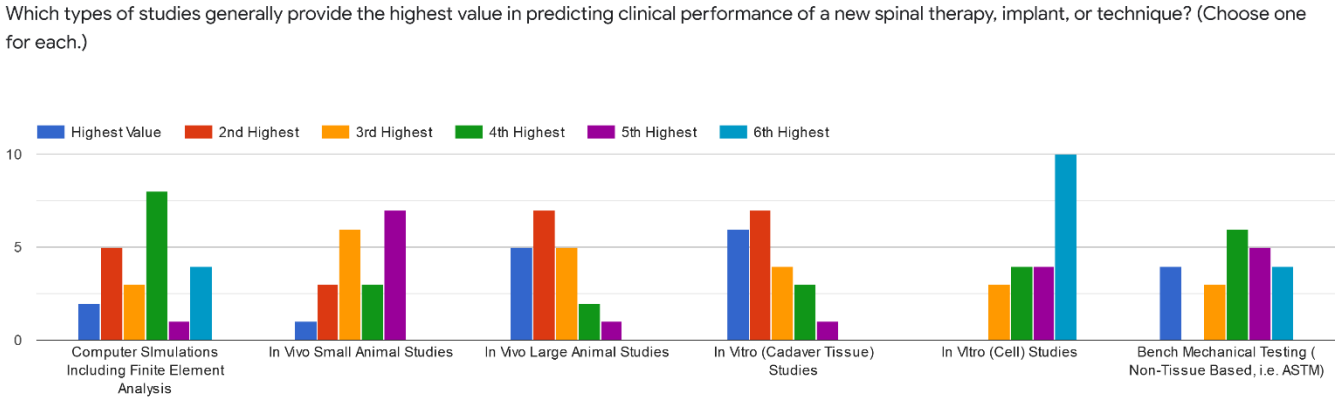
Survey Questions - Please skip any questions that are not relevant to you, or for which you have no opinion, or for which you have no experience. All questions are to be answered with respect to testing of HUMAN CADAVER motion segments unless specified otherwise. If you respond "Other", a comment box is provided. This survey will take approximately 15 minutes to complete.



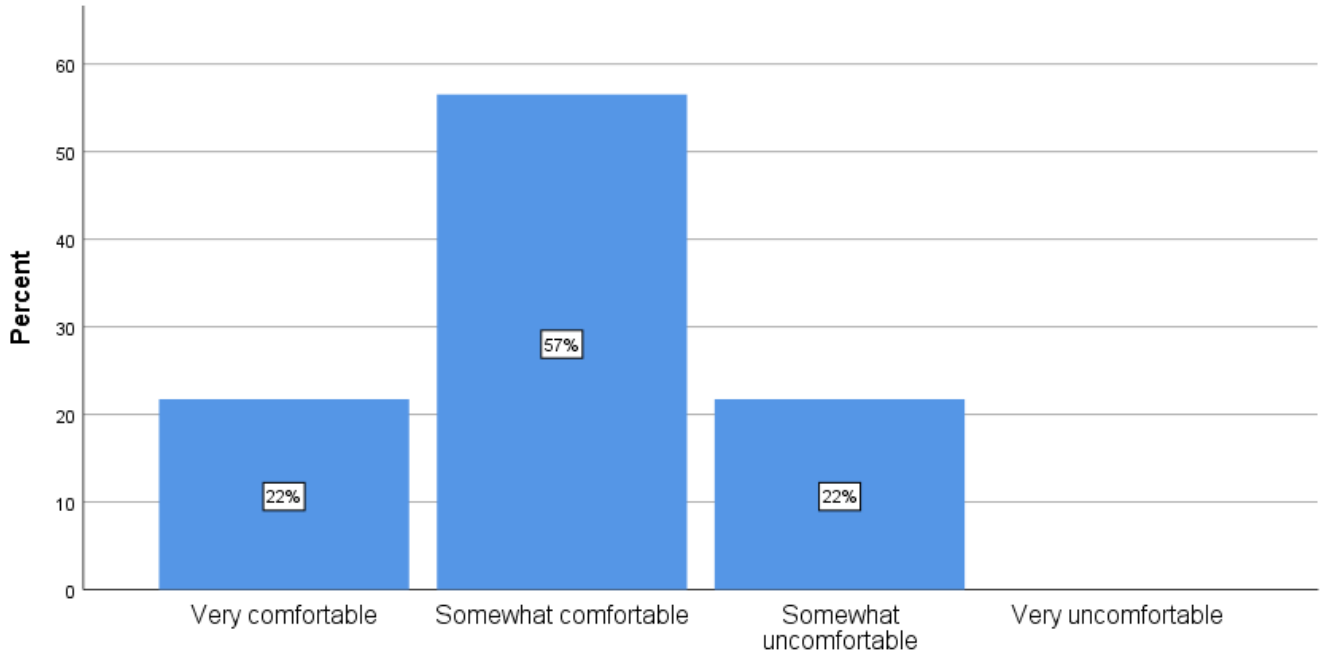


Q3 [Clinical Relevance] [Physicians only] Which types of studies generally provide the highest value in predicting clinical performance of a new spinal therapy, implant, or technique? (23 responses)

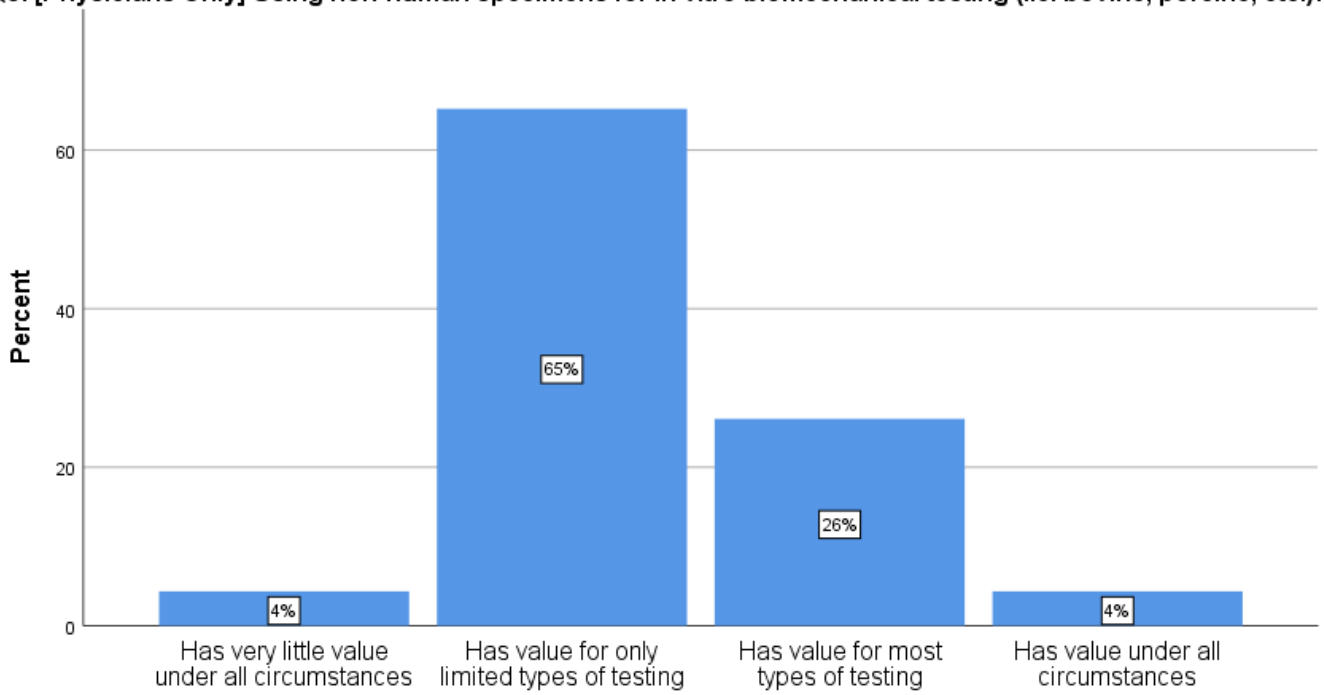
1. Computer simulations Including Finite Element Analysis
2. In Vivo Small Animal Studies
3. In Vivo Large Animal Studies
4. In Vitro (Cadaver) Studies
5. In Vitro (Cell) Studies
6. Bench Mechanical Testing (Non-Tissue Based, i.e. ASTM)



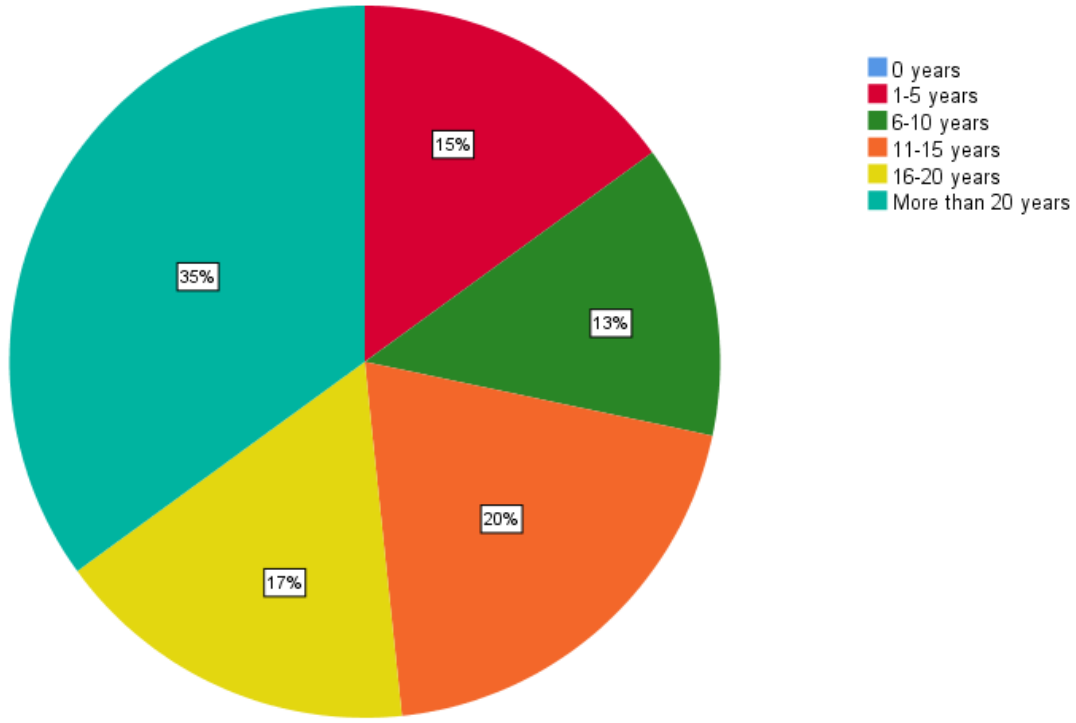
Q4. [Physicians Only] With respect to clinical relevance, what is your comfort level with interpreting biomechanical studies on motion segments?



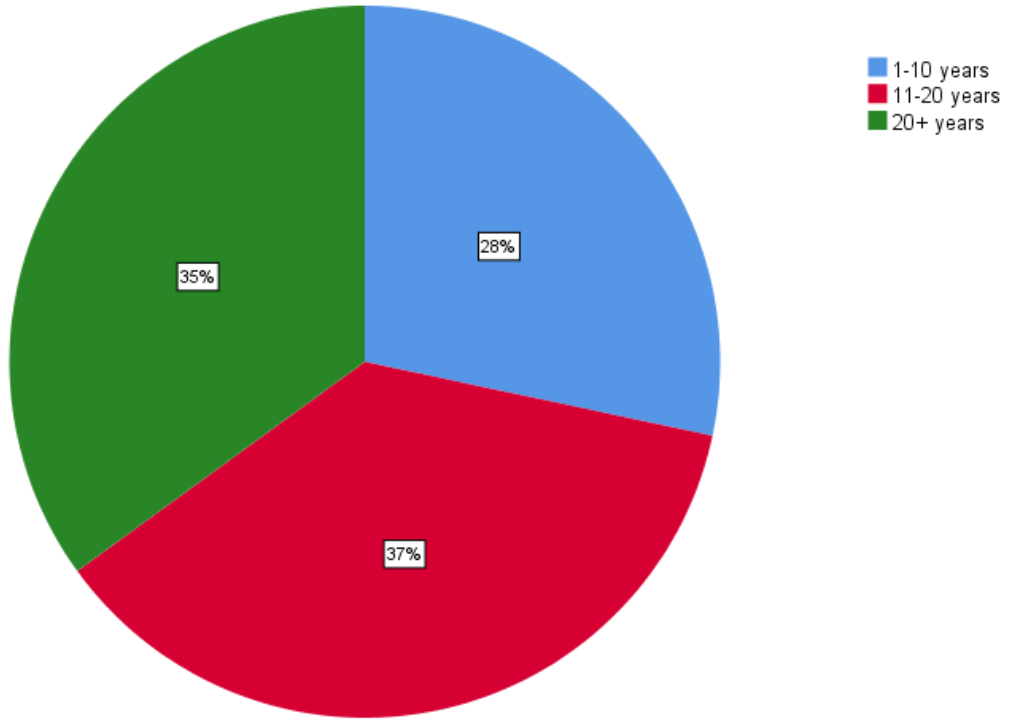
Q5. [Physicians Only] Using non-human specimens for in vitro biomechanical testing (i.e. bovine, porcine, etc.):



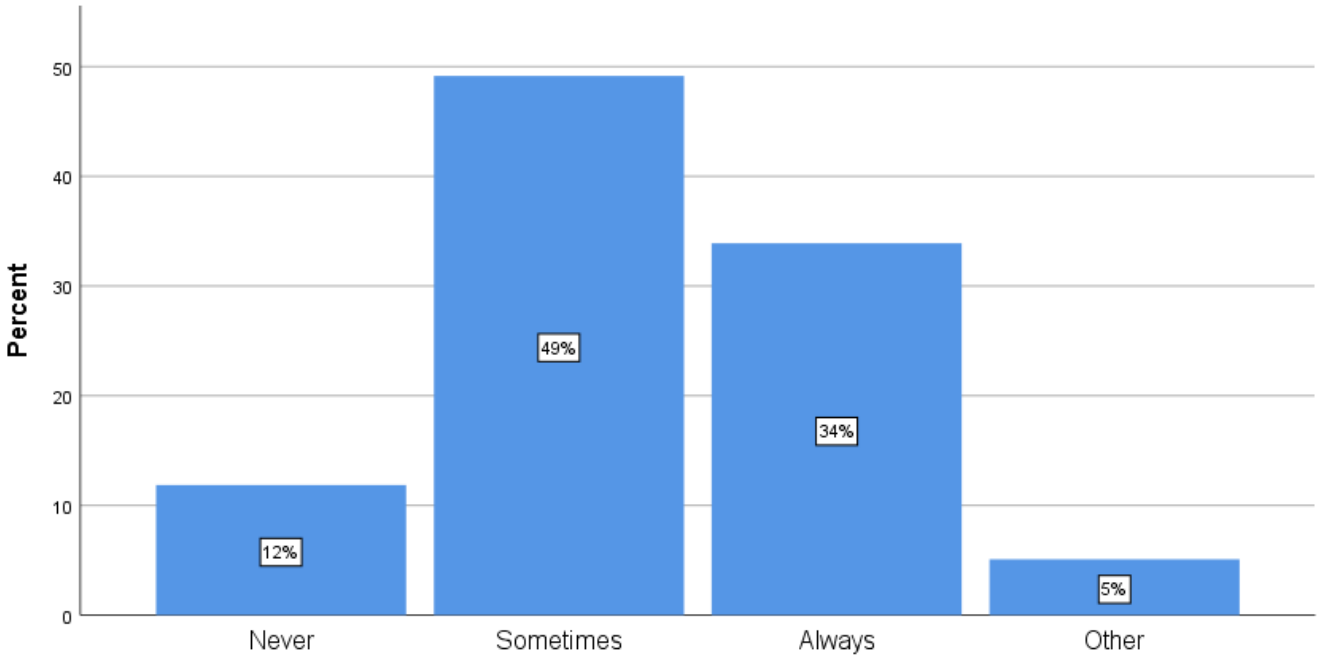
Q6. How many years experience do you have performing in vitro biomechanics research?



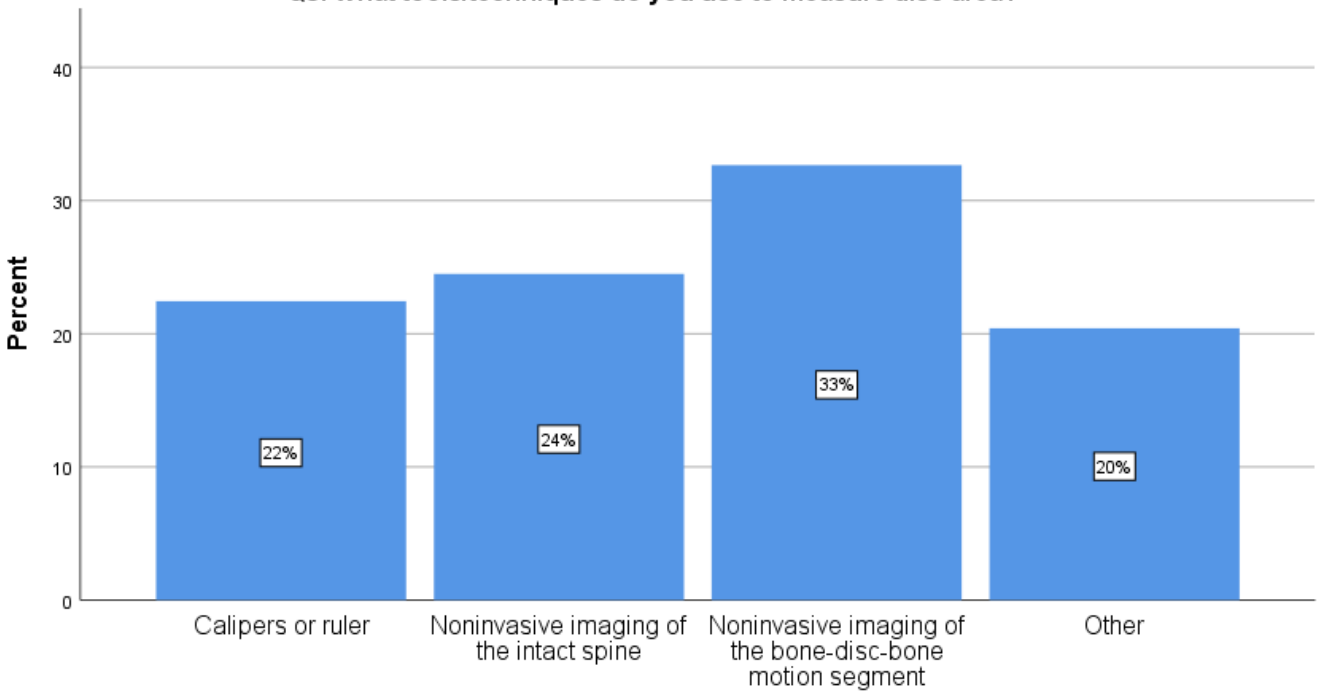
Q6. How many years experience do you have performing in vitro biomechanics research?



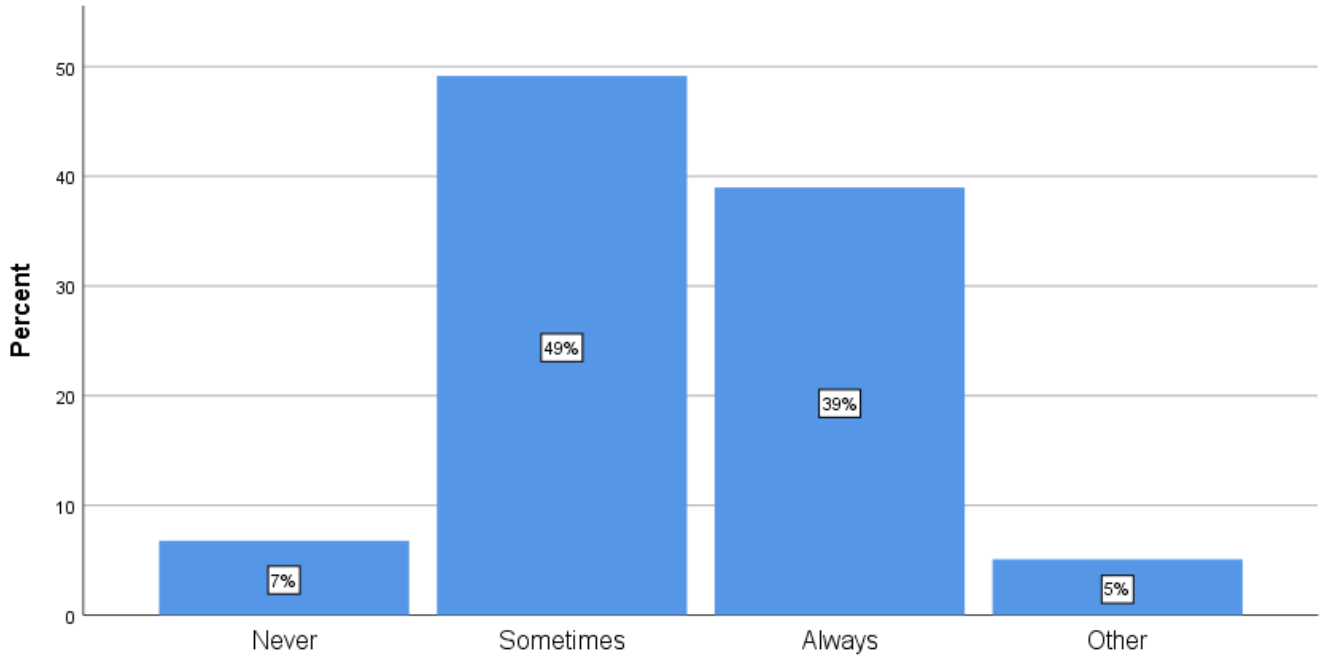
Q7. When preparing samples for cadaver biomechanical testing, do you measure disc area prior to testing?



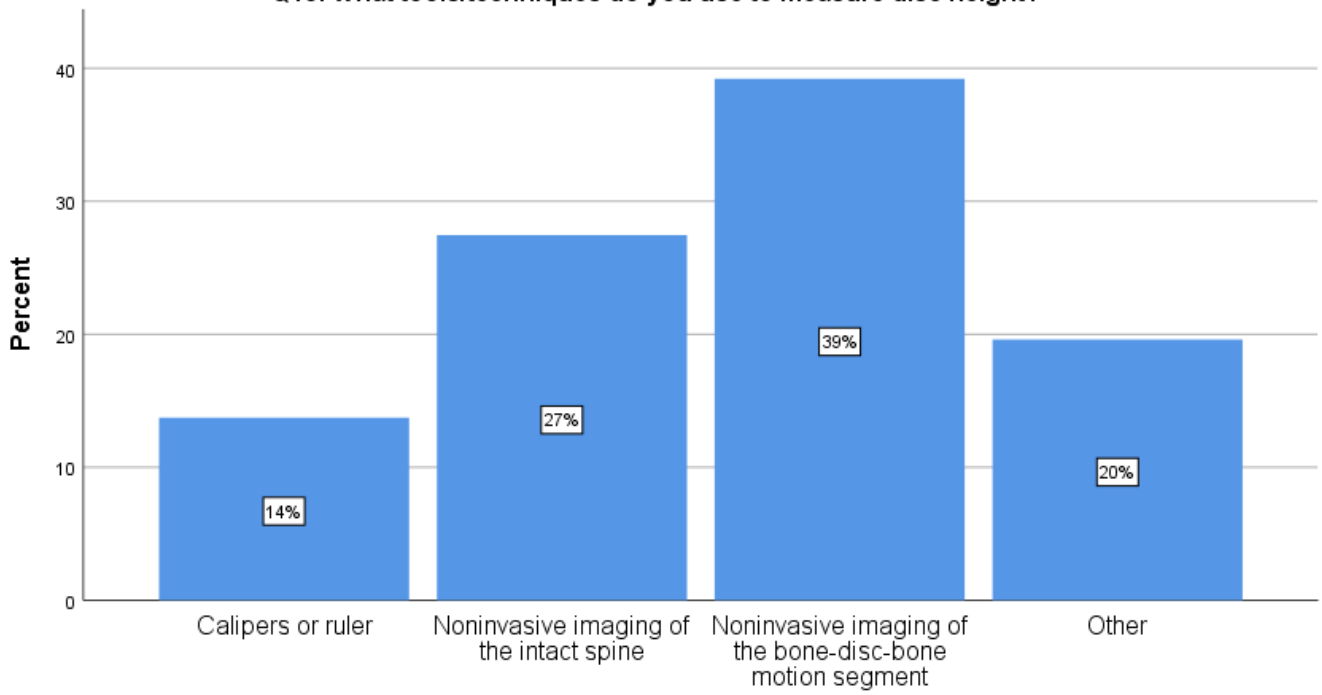
Q8. What tools/techniques do you use to measure disc area?



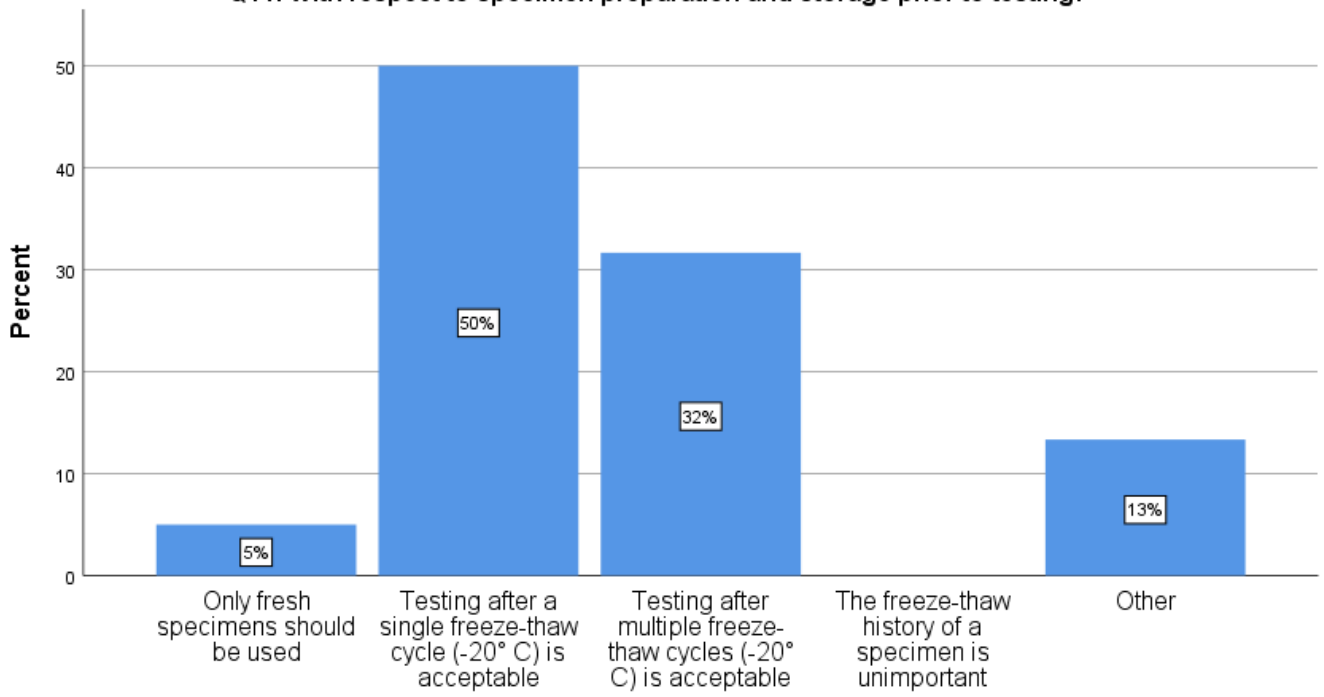
Q9. When preparing samples for cadaver biomechanical testing, do you measure disc height prior to testing?



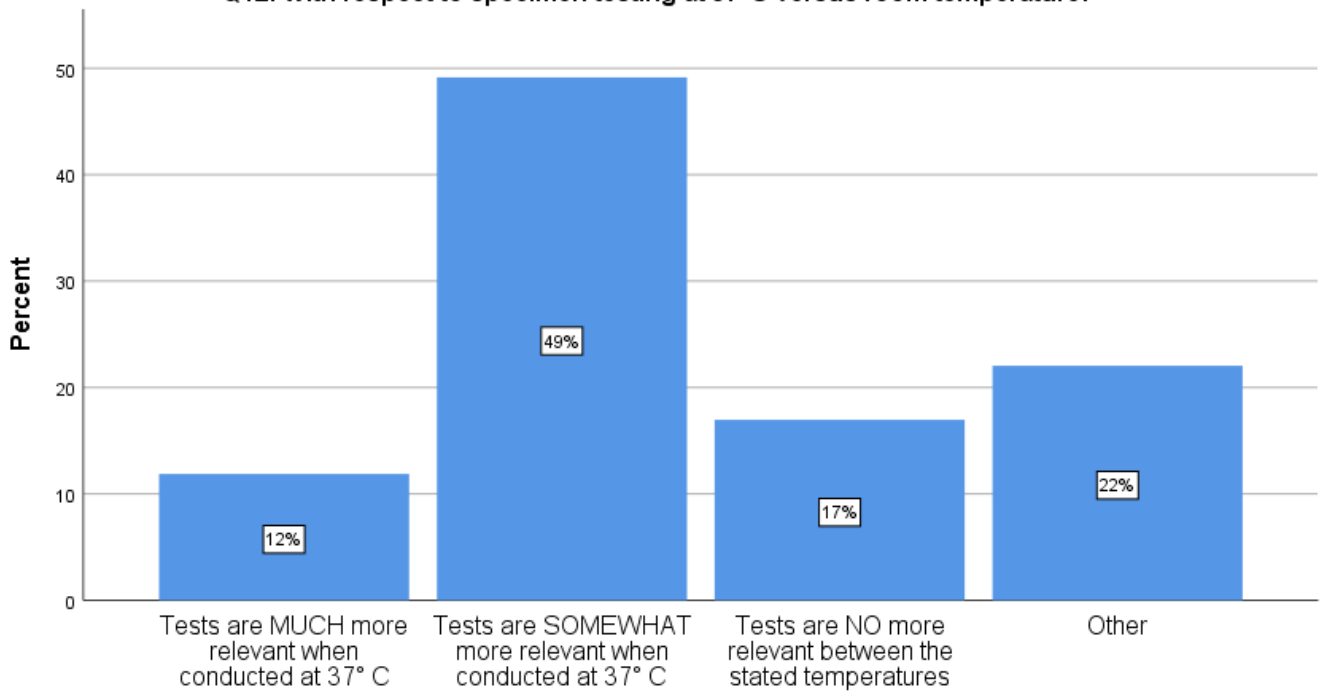
Q10. What tools/techniques do you use to measure disc height?

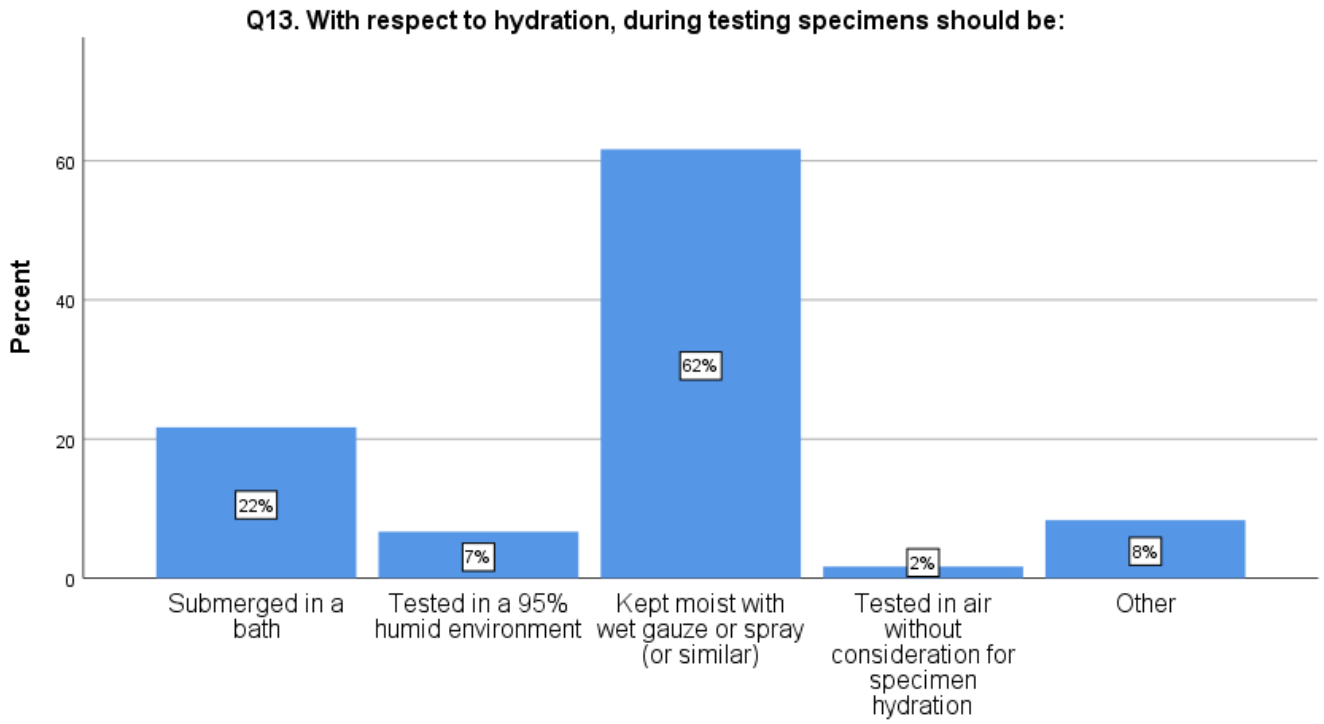


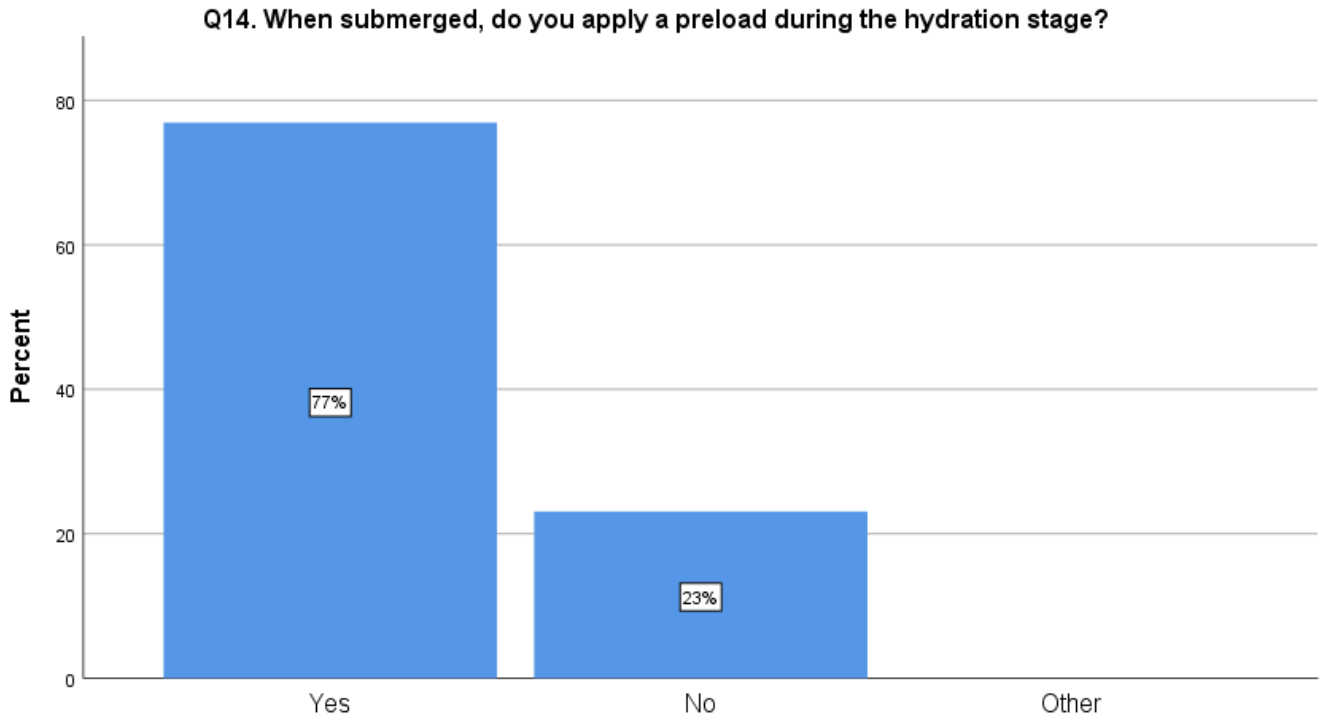
Q11. With respect to specimen preparation and storage prior to testing:



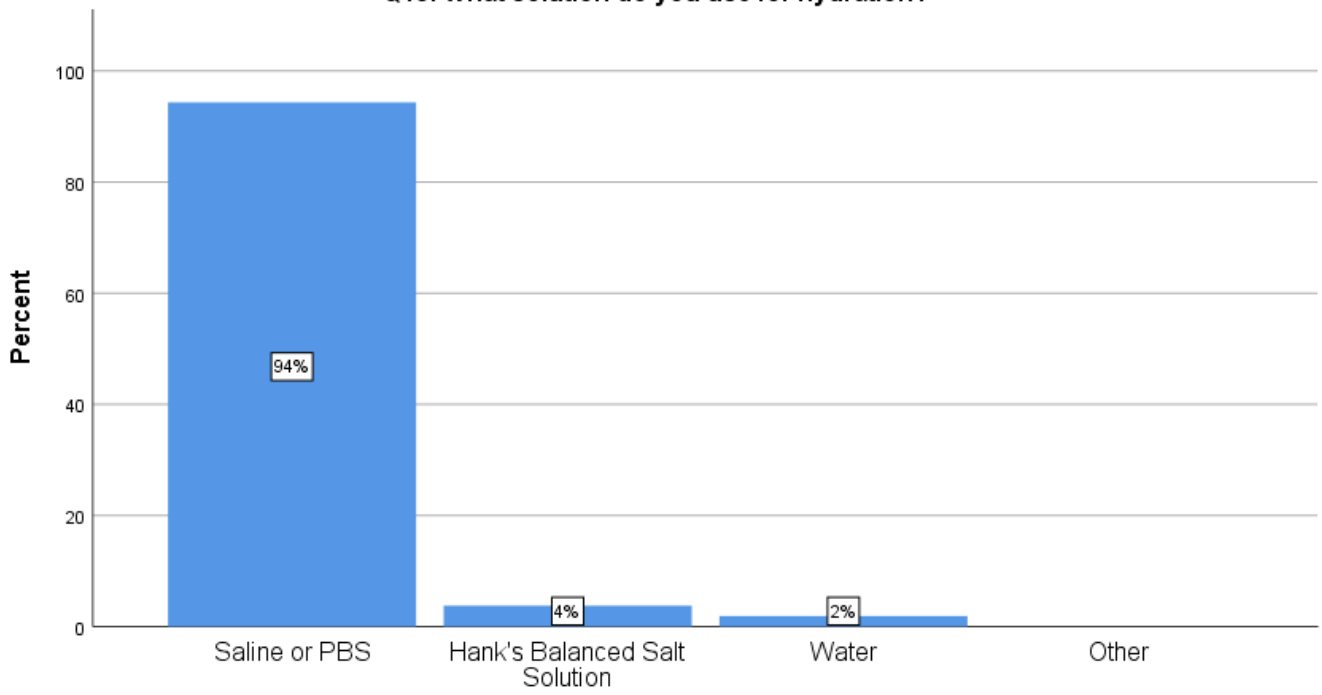
Q12. With respect to specimen testing at 37°C versus room temperature:



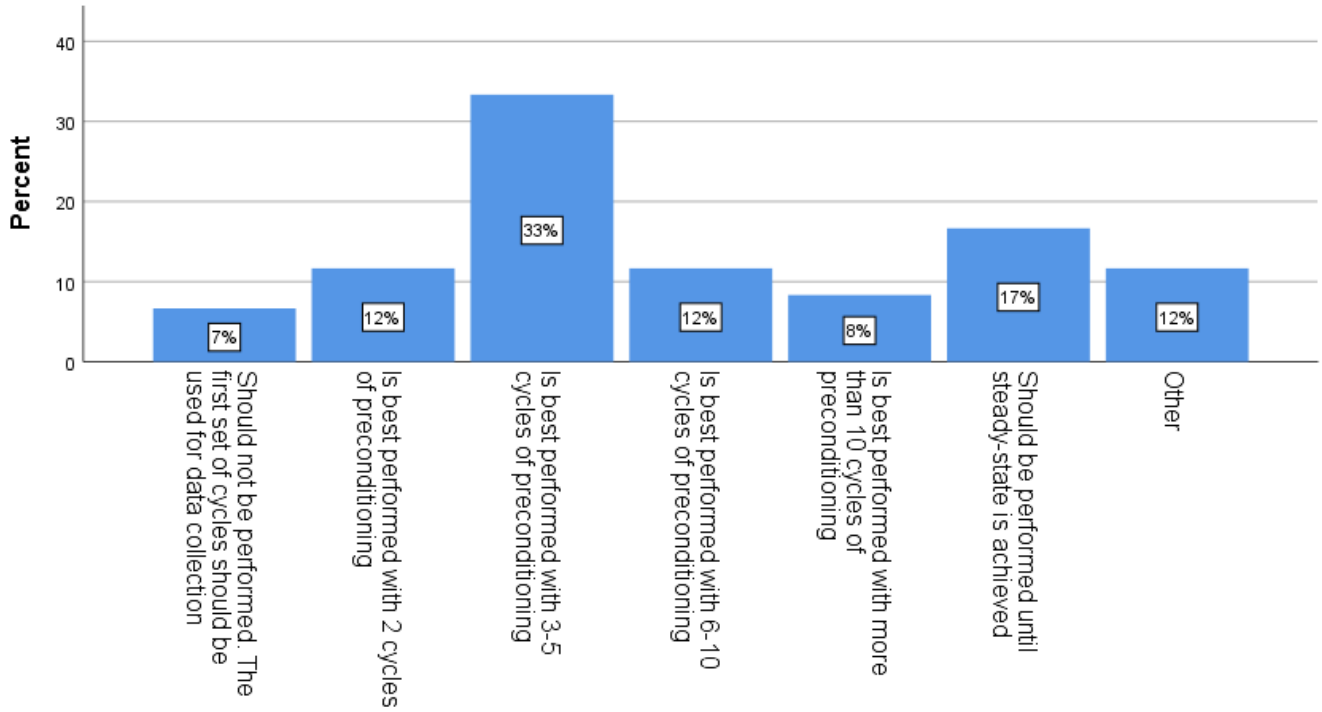

Q13. With respect to hydration, during testing specimens should be:
Percent
60
40
20
0
22%
7%
62%
2%
8%
Submerged in a bath
Tested in a 95% humid environment
Kept moist with wet gauze or spray (or similar)
Tested in air without consideration for specimen hydration
Other


Q14. When submerged, do you apply a preload during the hydration stage?
Percent
80
60
40
20
0
77%
23%
Yes
No
Other

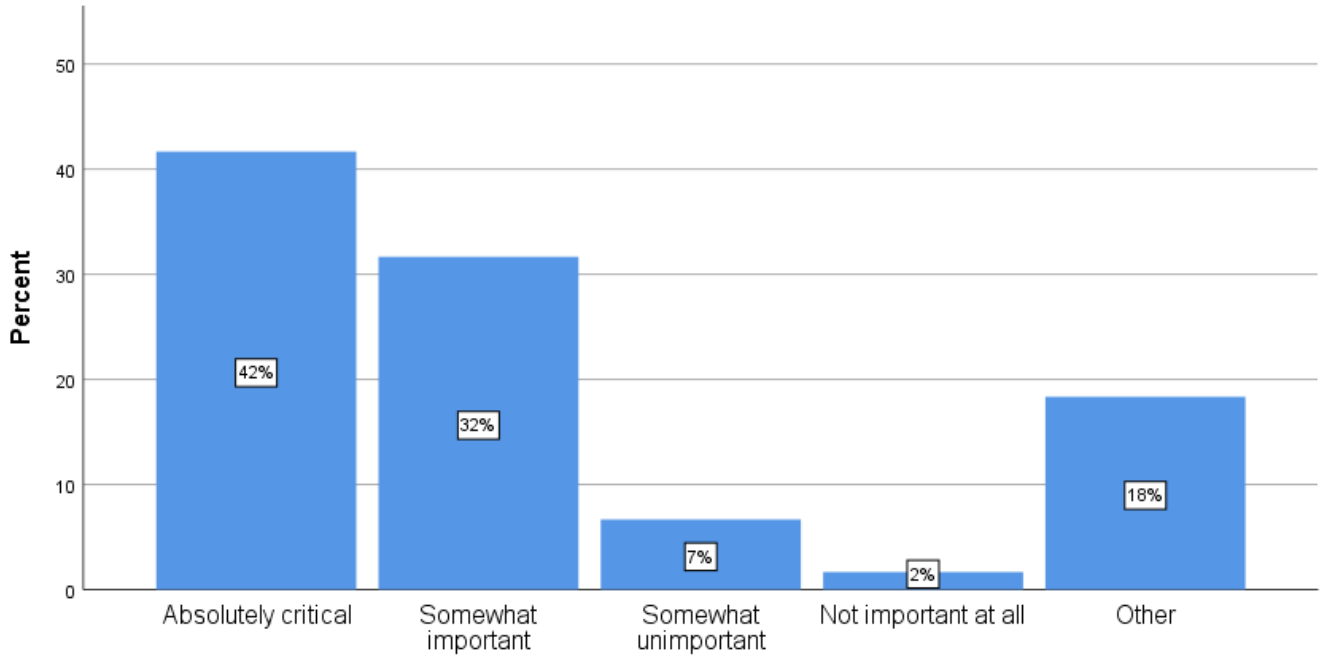
Q15. What solution do you use for hydration?



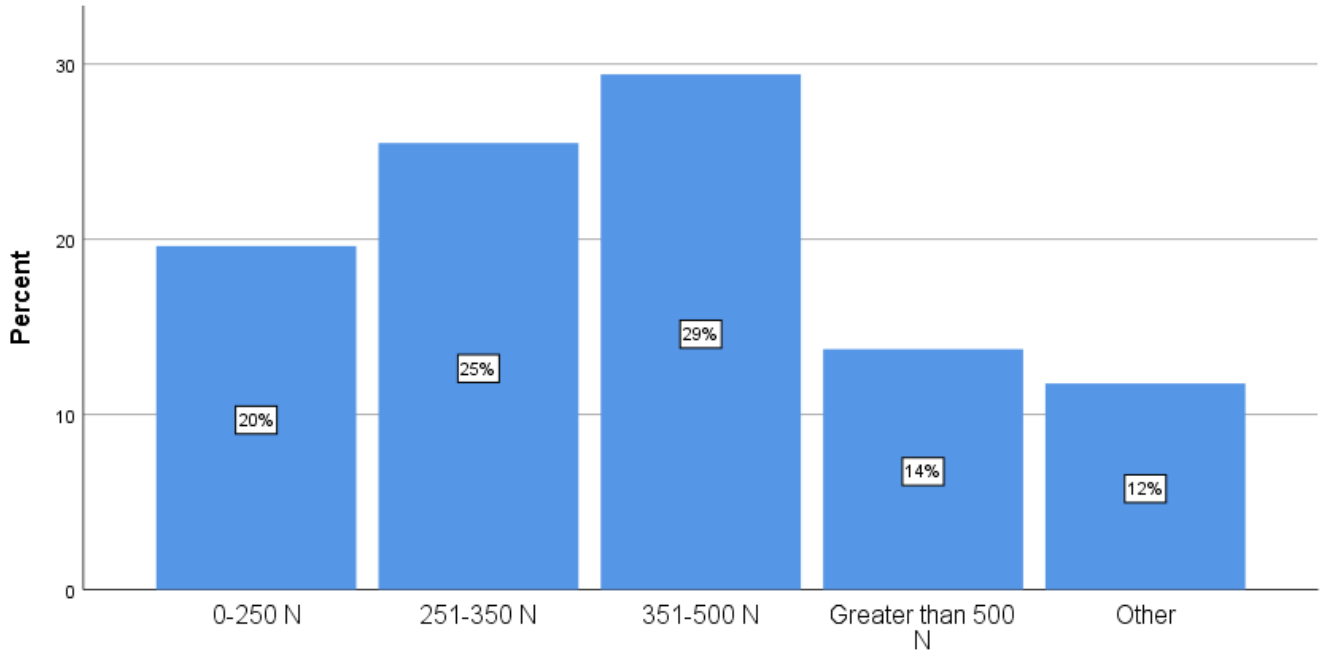
Q16. For cadaver in vitro biomechanical testing, preconditioning of specimens before collecting data:



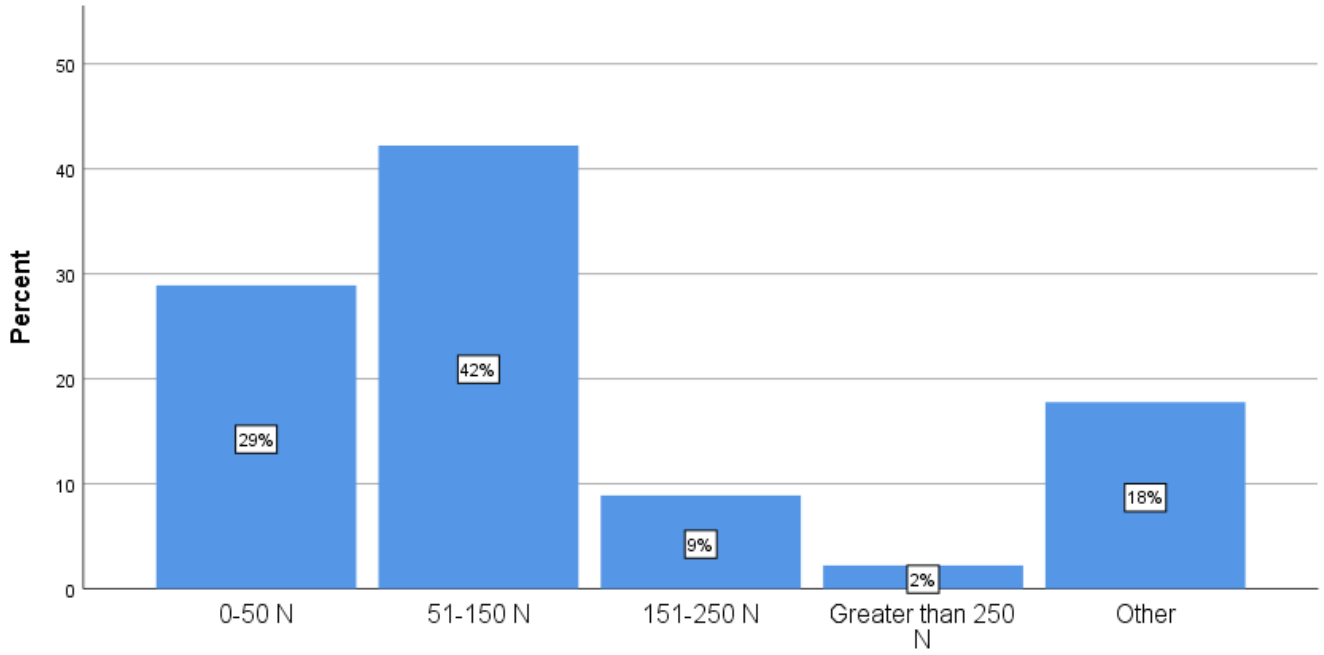
Q17. During in vitro cadaver bending or rotation testing, how important is it to apply an axial compressive "pre-load" to specimens?



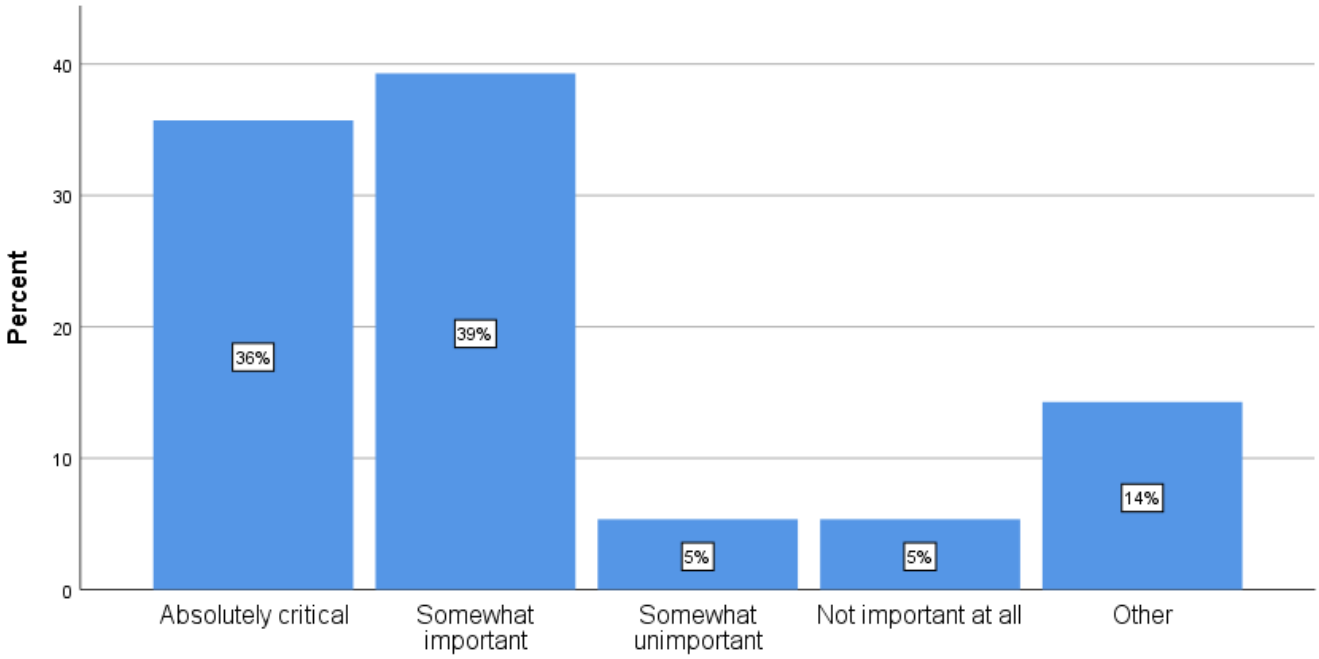
Q18. For testing LUMBAR spine specimens, what magnitude of axial compressive "pre-load" is most appropriate during bending or rotation testing?

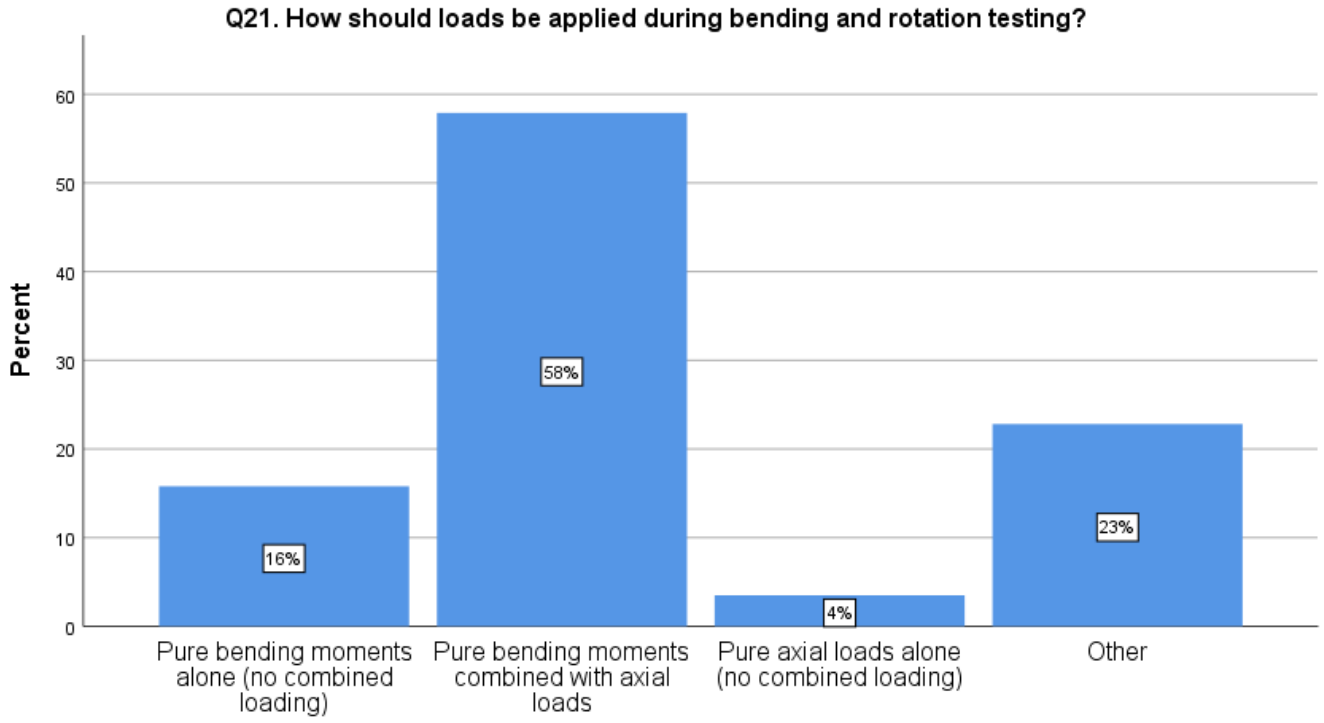


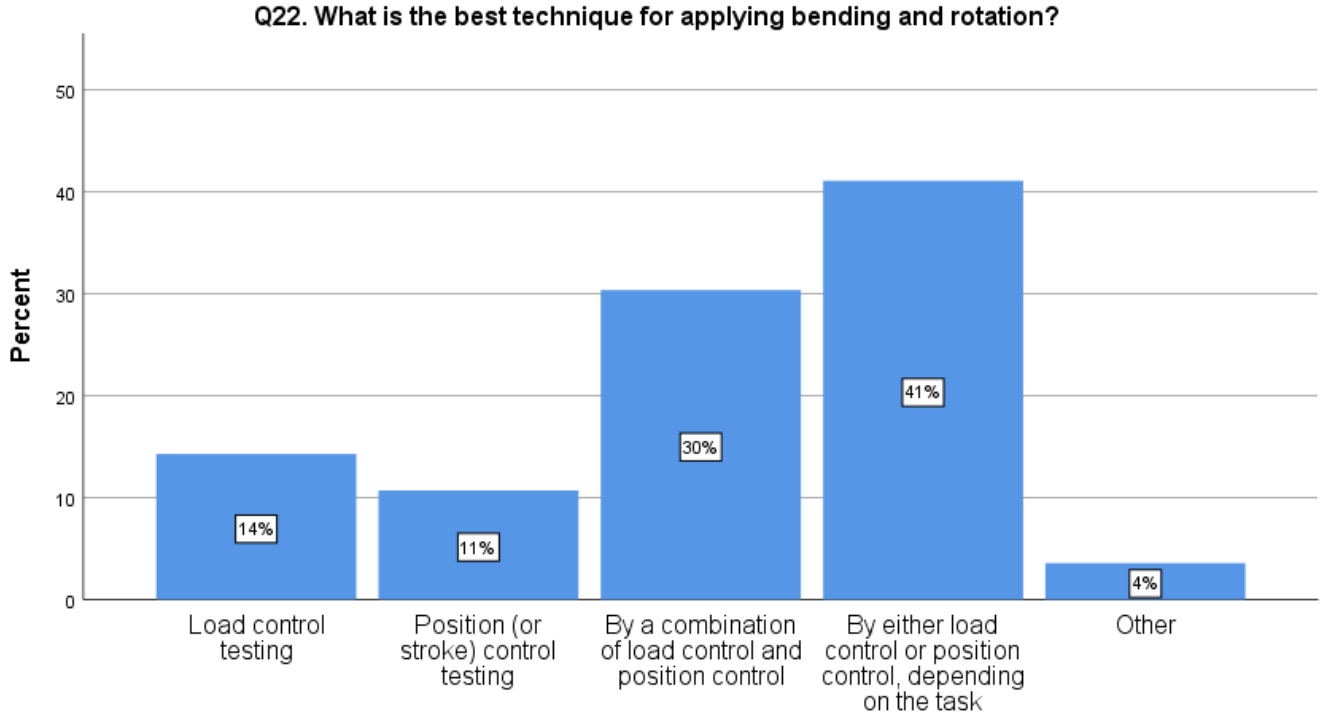
Q19. For testing CERVICAL spine specimens, what magnitude of axial compressive "pre-load" is most appropriate during bending or rotation testing?



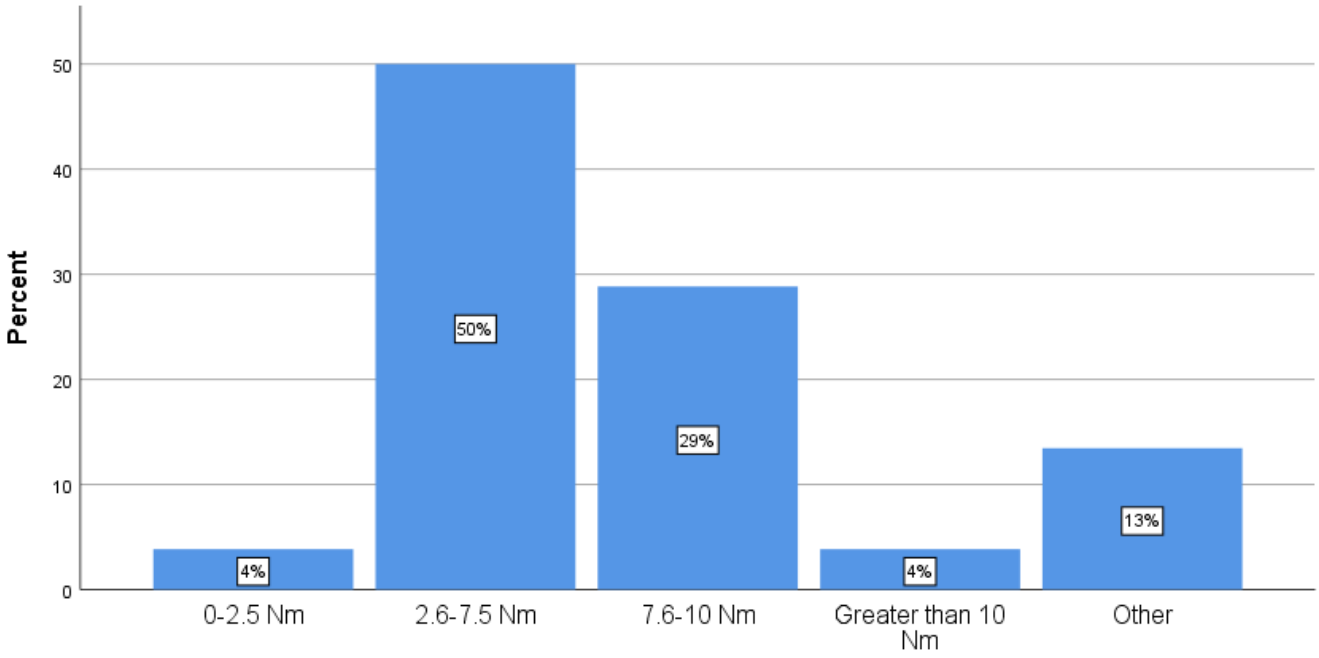
Q20. During in vitro range of motion testing, how important is it to apply pure bending to specimens?



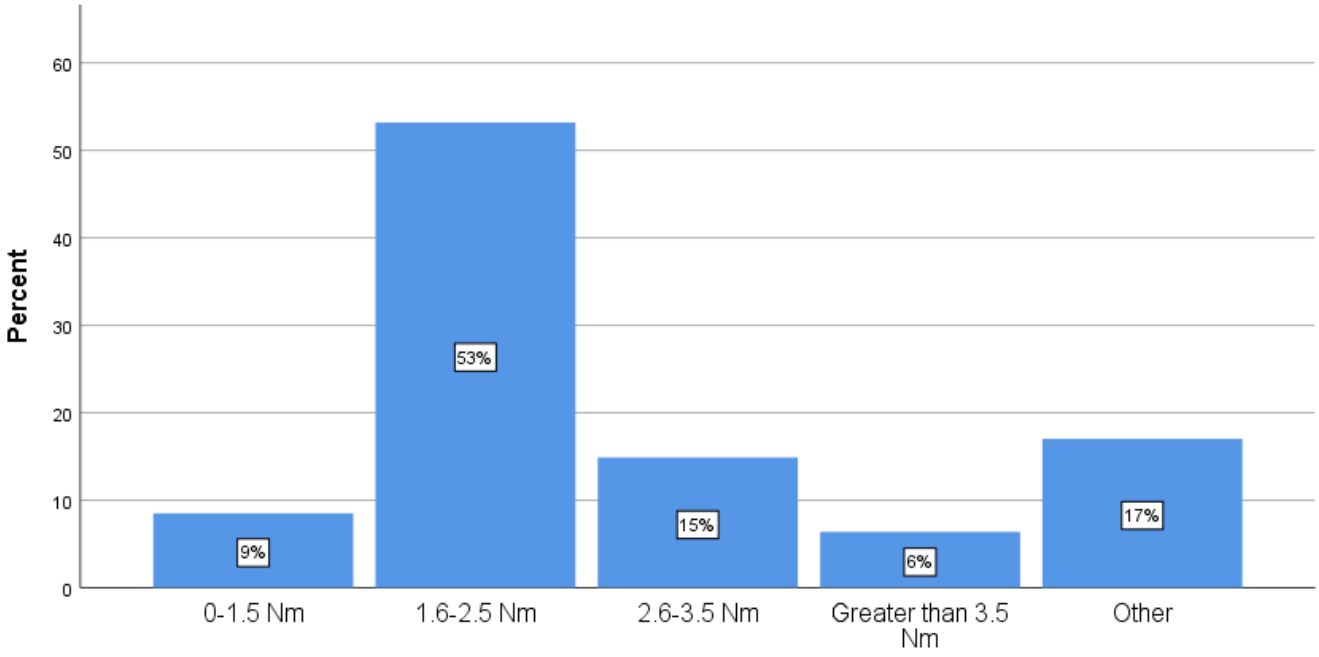

Q21. How should loads be applied during bending and rotation testing?
Percent
60
50
40
30
20
10
0
16%
58%
4%
23%
Pure bending moments alone (no combined loading)
Pure bending moments combined with axial loads
Pure axial loads alone (no combined loading)
Other


Q22. What is the best technique for applying bending and rotation?
Percent
50
40
30
20
10
0
14%
11%
30%
41%
4%
Load control testing
Position (or stroke) control testing
By a combination of load control and position control
By either load control or position control, depending on the task
Other

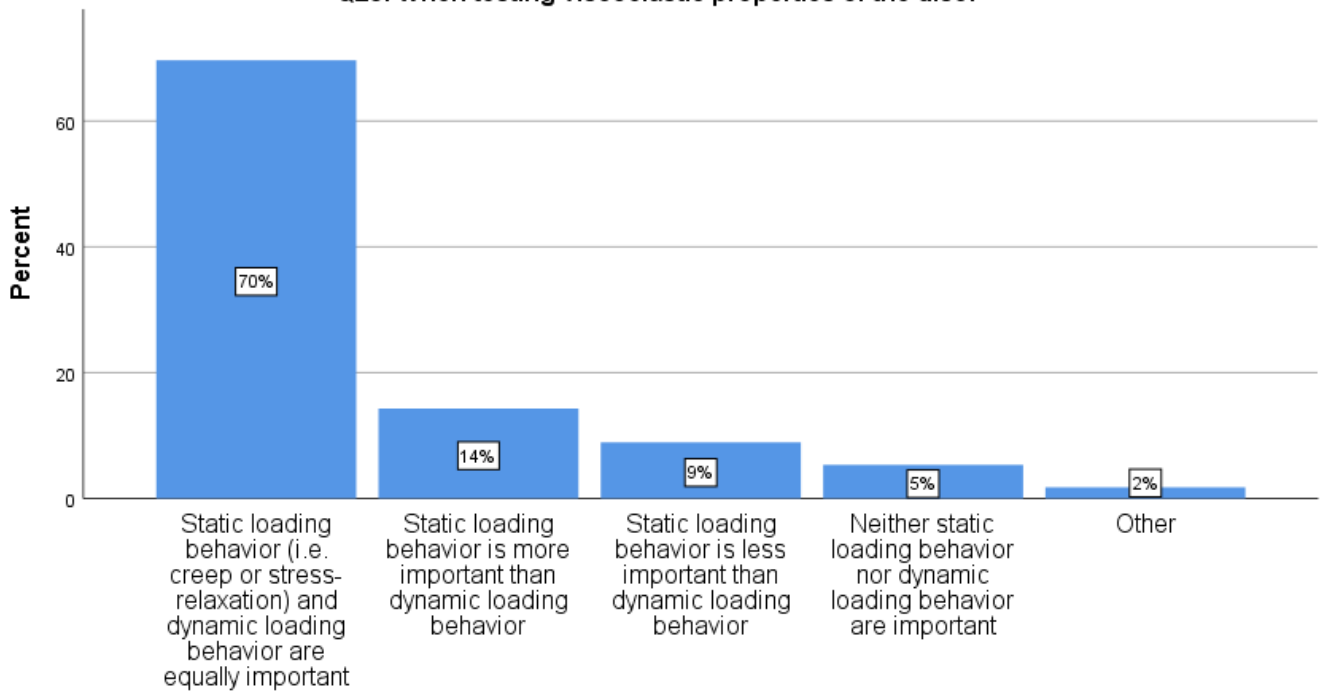
Q23. For testing LUMBAR specimens, what magnitude of bending moment should be applied in flexion/extension and lateral bending to mimic physiological loading?



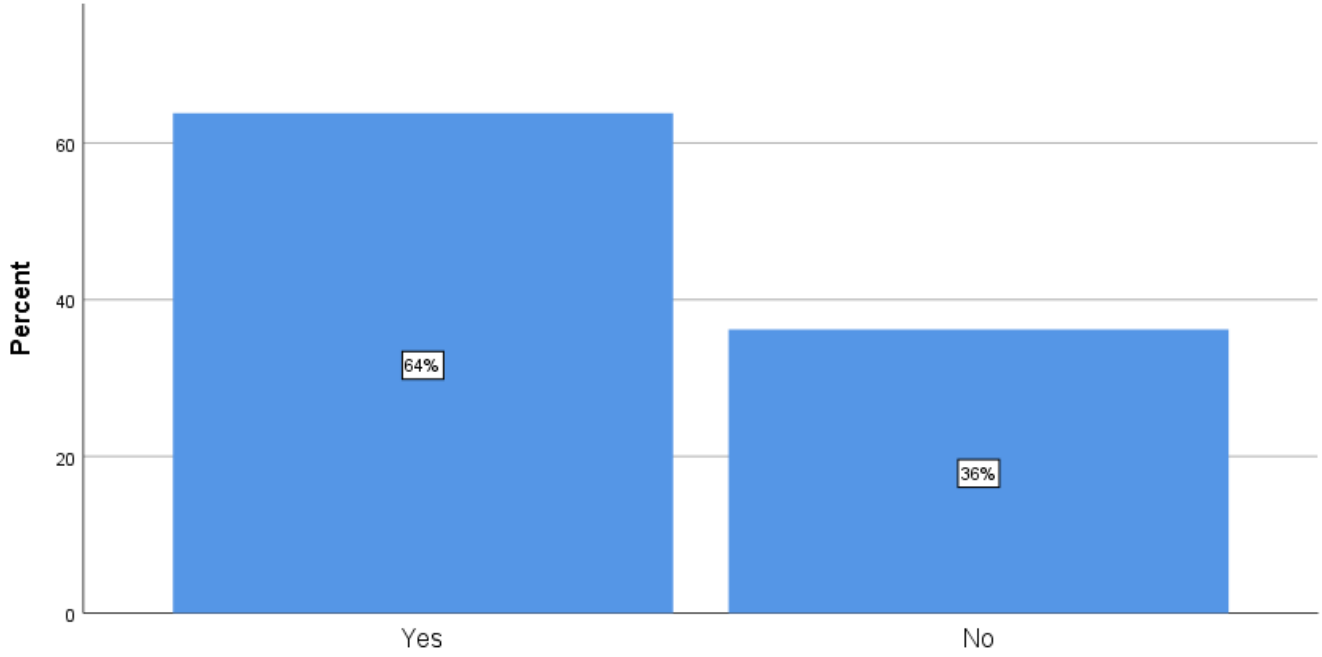
Q24. For testing CERVICAL specimens, what magnitude of bending moment should be applied in flexion/extension and lateral bending to mimic physiological loading?



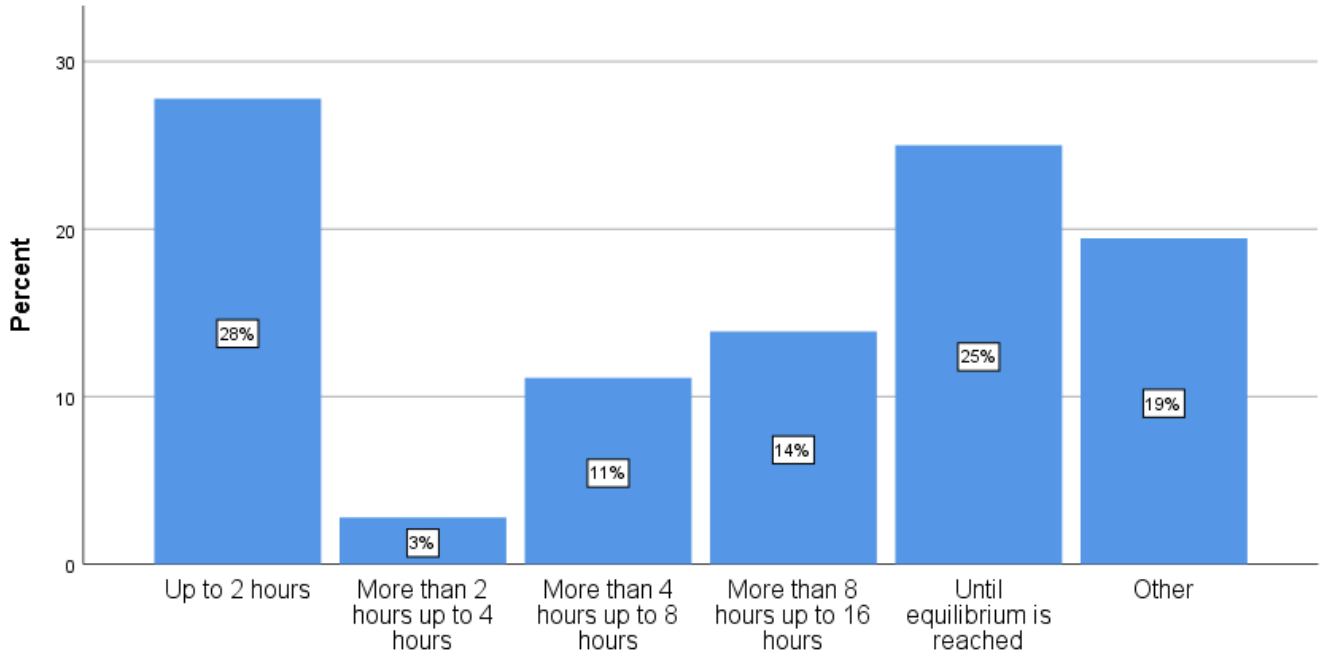
Q25. When testing viscoelastic properties of the disc:



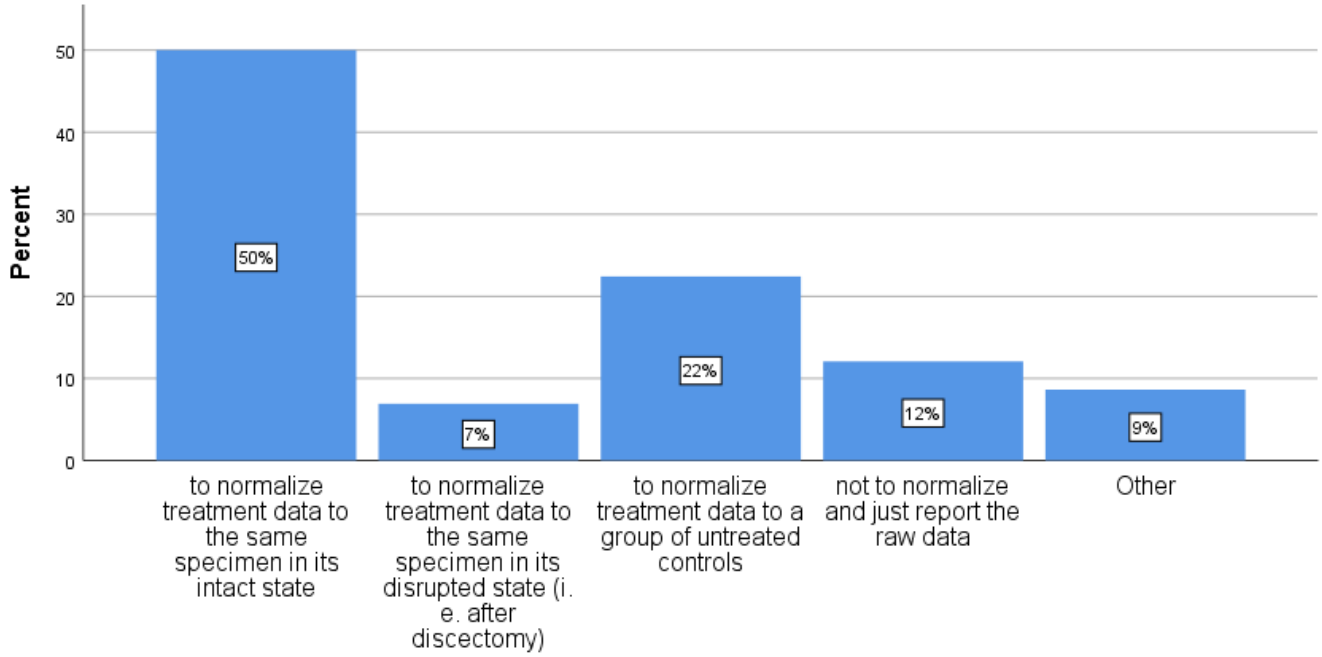
Q26. Do you have experience performing static loading (i.e. creep or stress-relaxation) to study the time-dependent behavior of the disc?

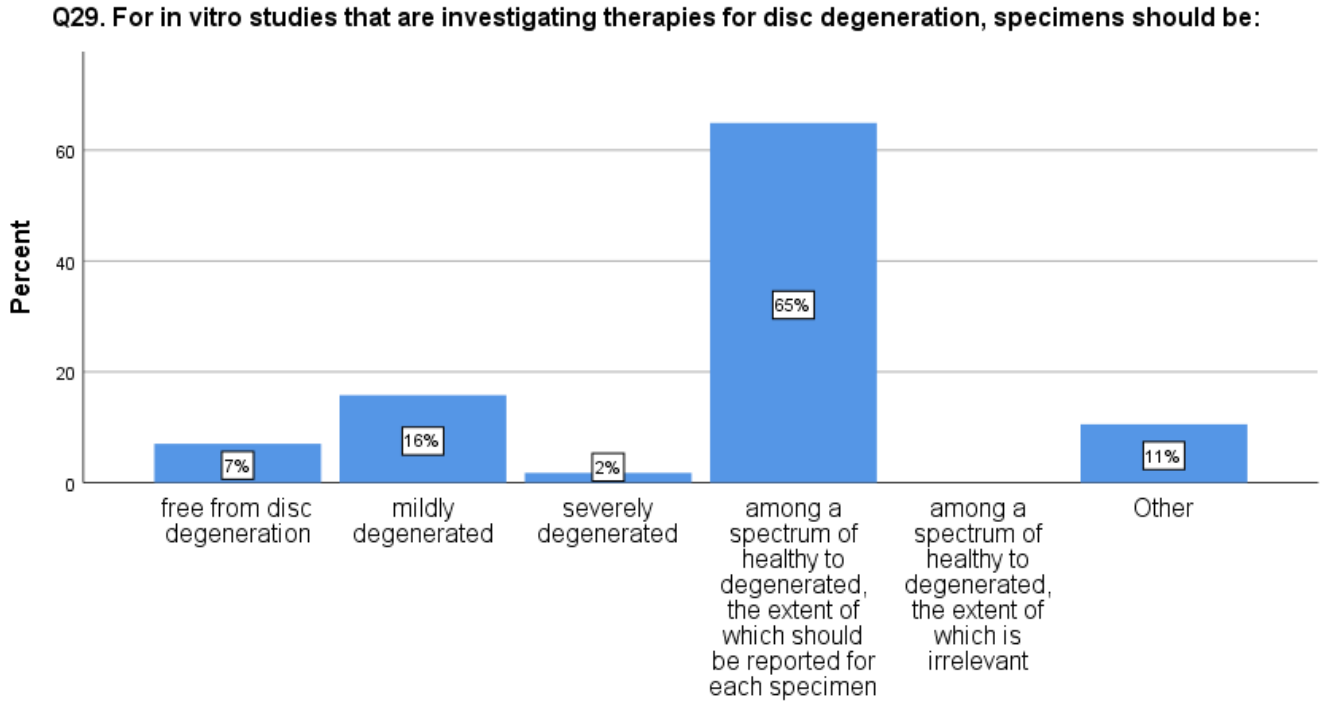


Q27. How long should static loading be applied to study the time-dependent behavior of the disc?



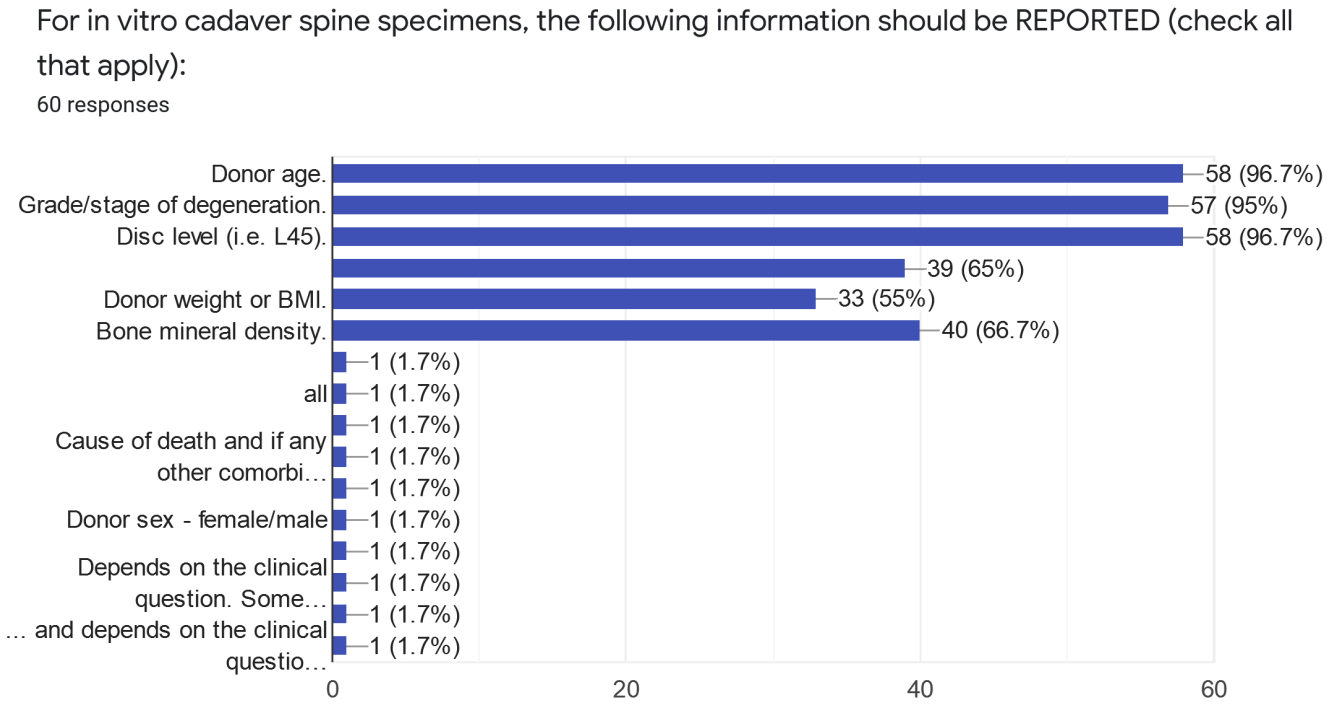
Q28. For reporting the effect that a treatment has on the mechanical properties of a motion segment, it is best:





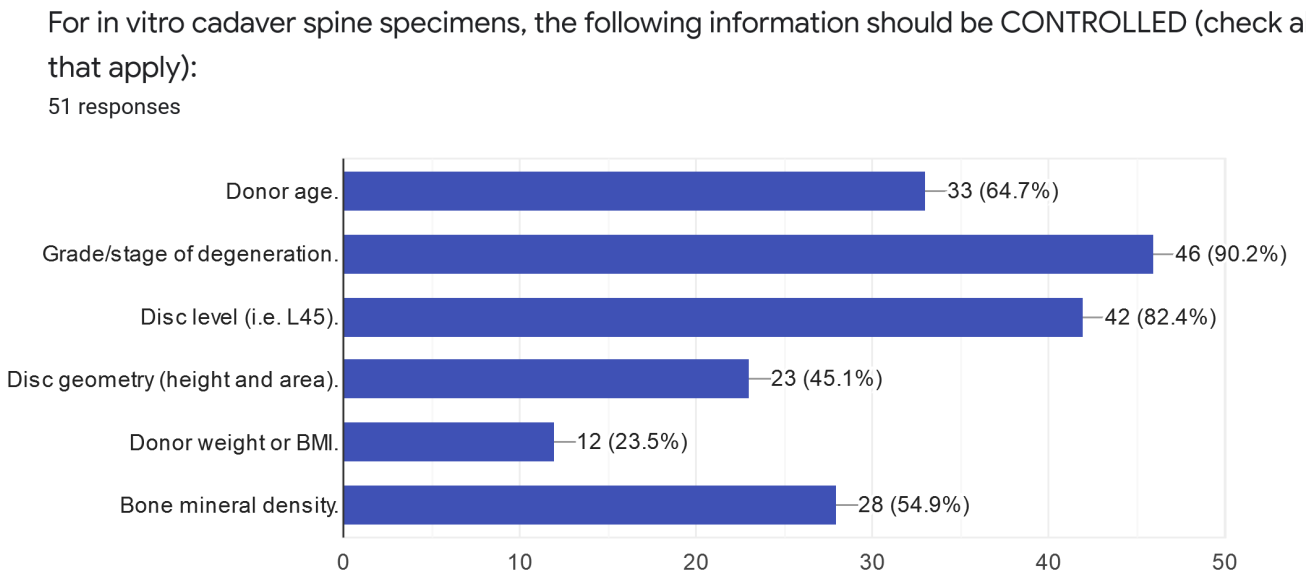
Q30 [Sample Selection & Preparation] For in vitro cadaver spine specimens, the following information should be REPORTED (check all that apply): (60 responses)

1. Donor age
2. Grade/stage of degeneration
3. Disc level (i.e. L45)
4. Disc geometry (height and area).
5. Donor weight or BMI.
6. Bone mineral density.
7. Other

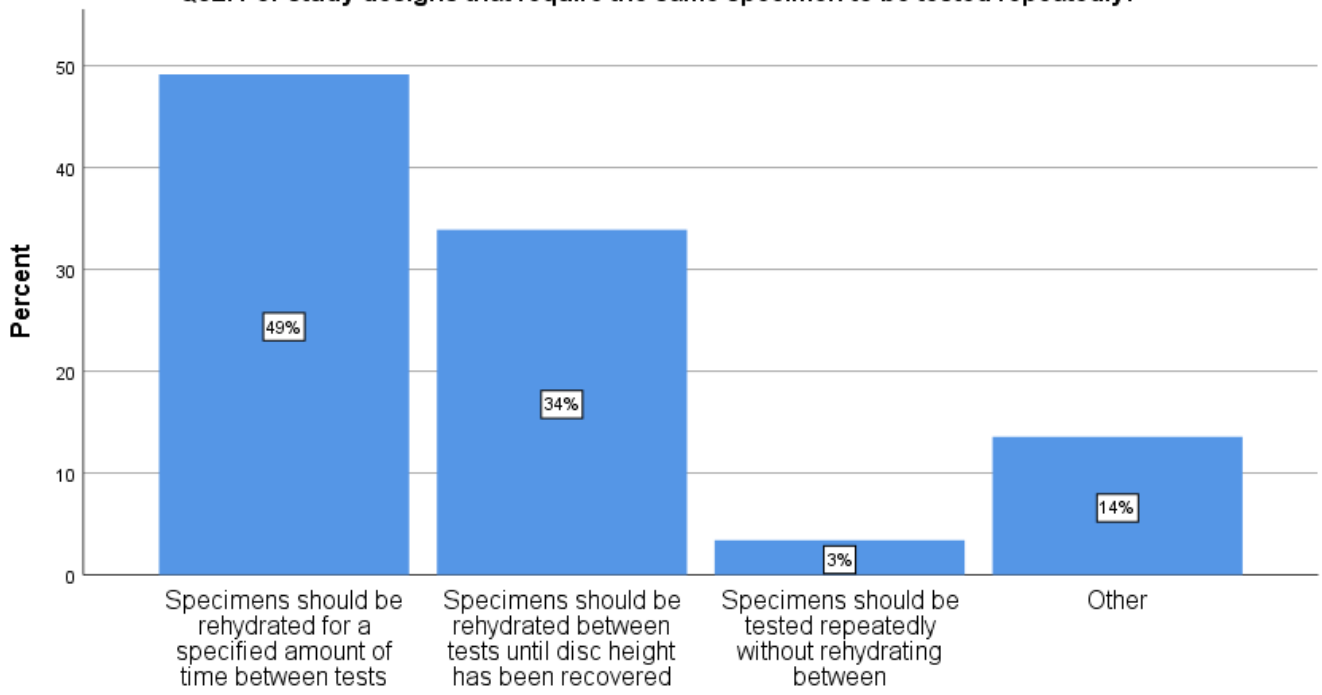


Q31 [Sample Selection & Preparation] For in vitro cadaver spine specimens, the following information should be CONTROLLED (check all that apply): (51 responses)

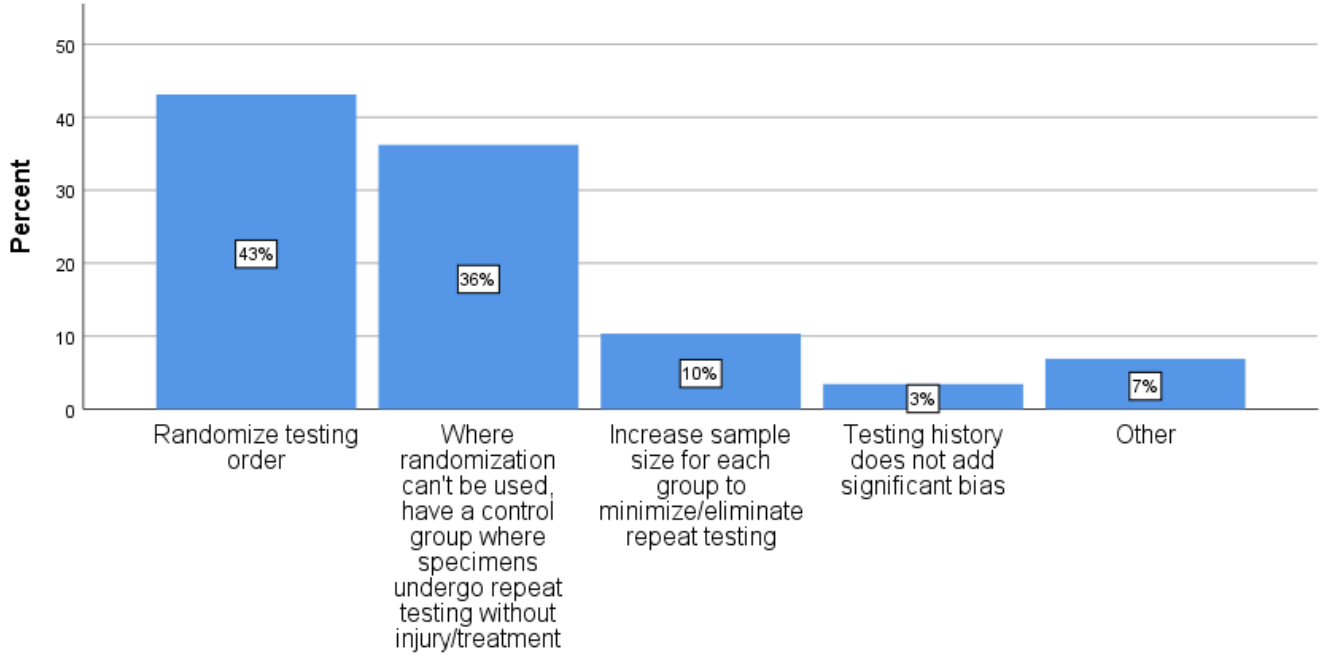
1. Donor age
2. Grade/stage of degeneration
3. Disc level (i.e. L45)
4. Disc geometry (height and area).
5. Donor weight or BMI.
6. Bone mineral density.
7. Other



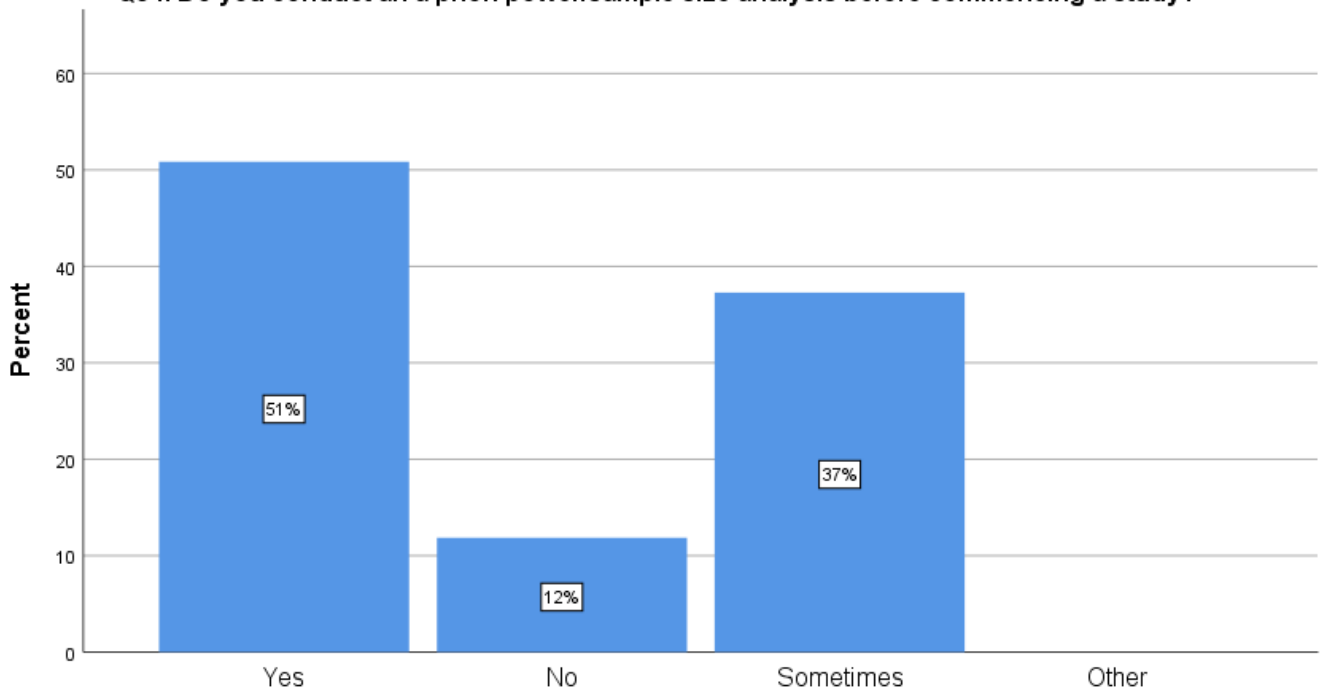
Q32. For study designs that require the same specimen to be tested repeatedly:



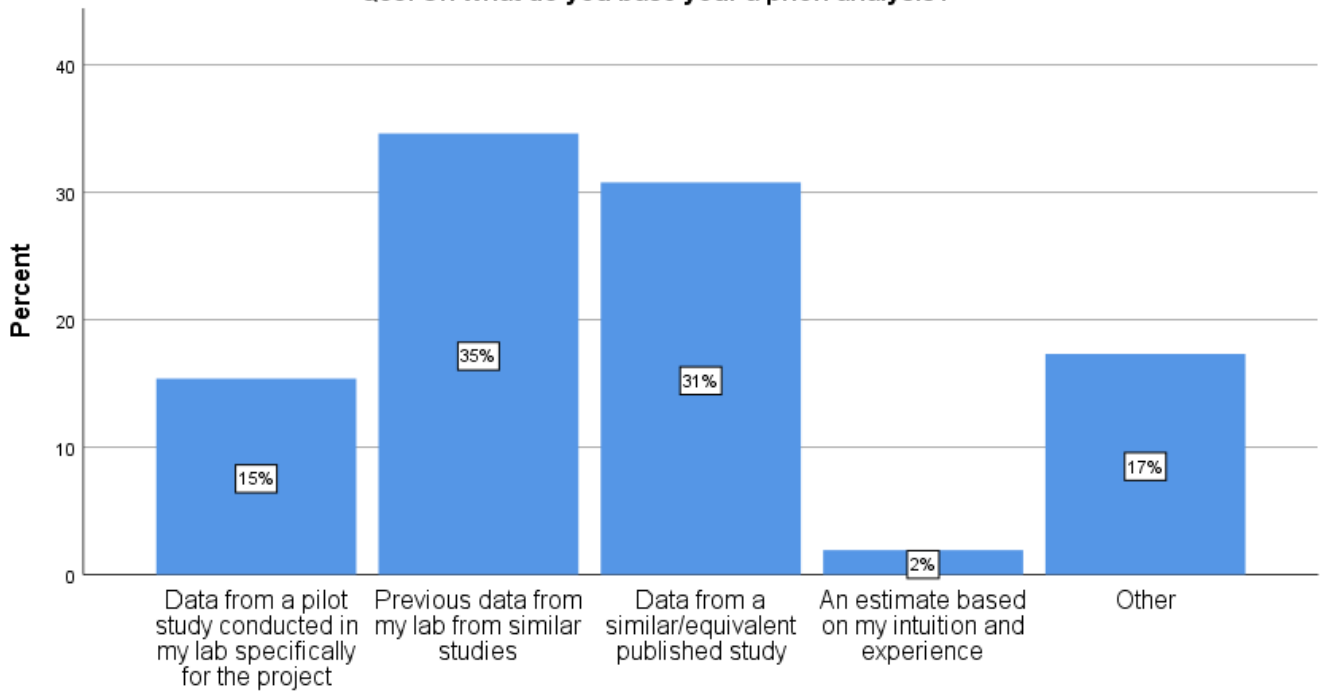
Q33. When performing repeated testing on specimens, how do you eliminate bias from testing history?

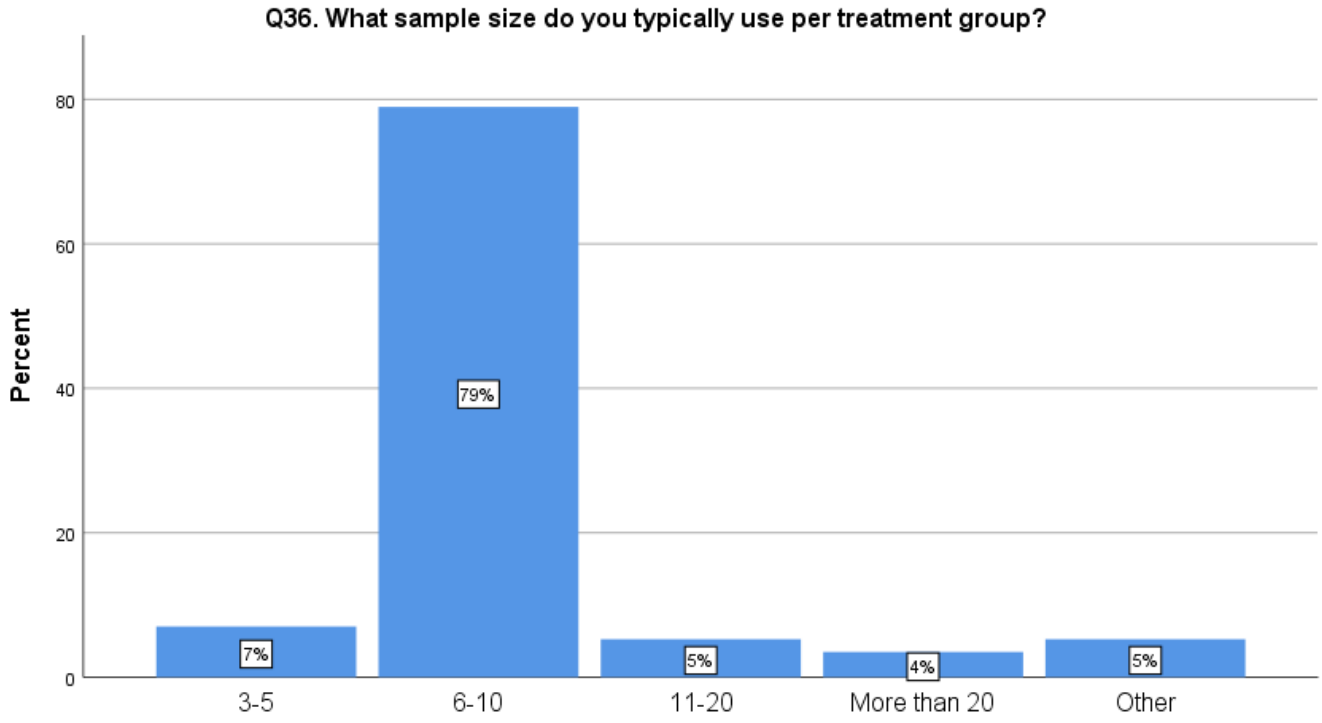


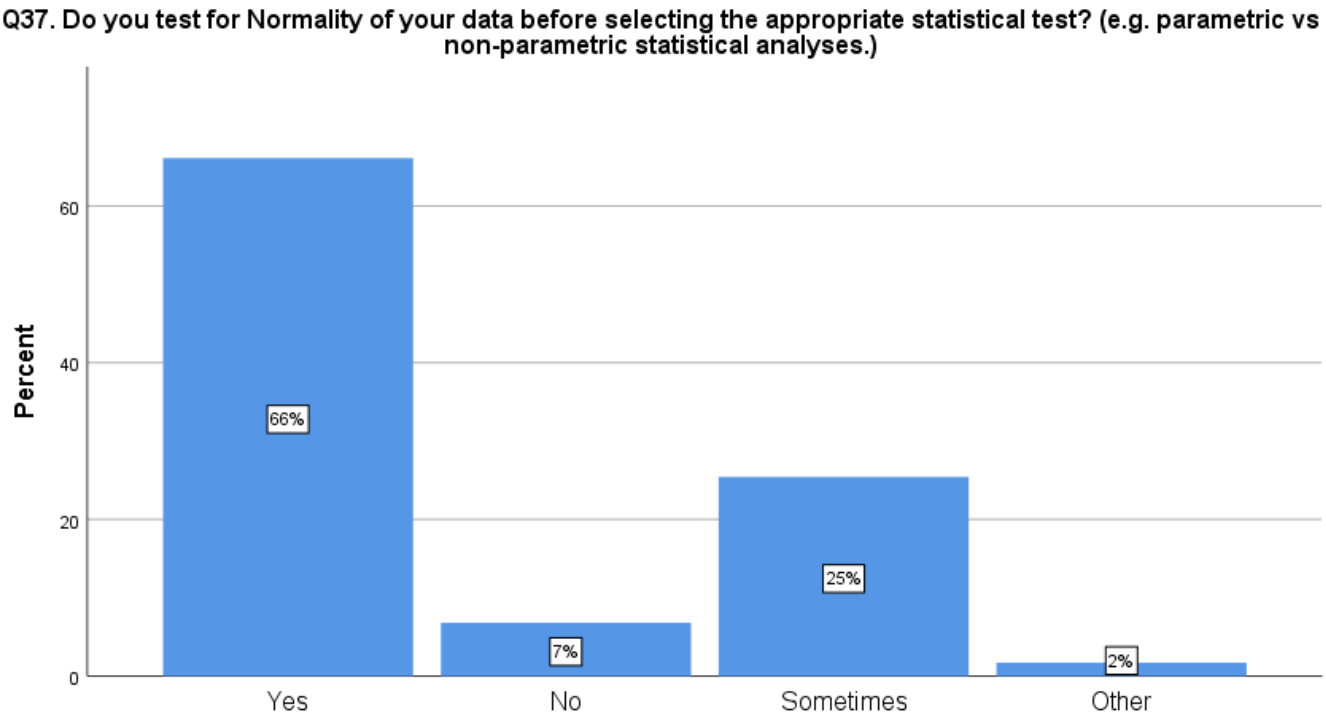
Q34. Do you conduct an a priori power/sample size analysis before commencing a study?



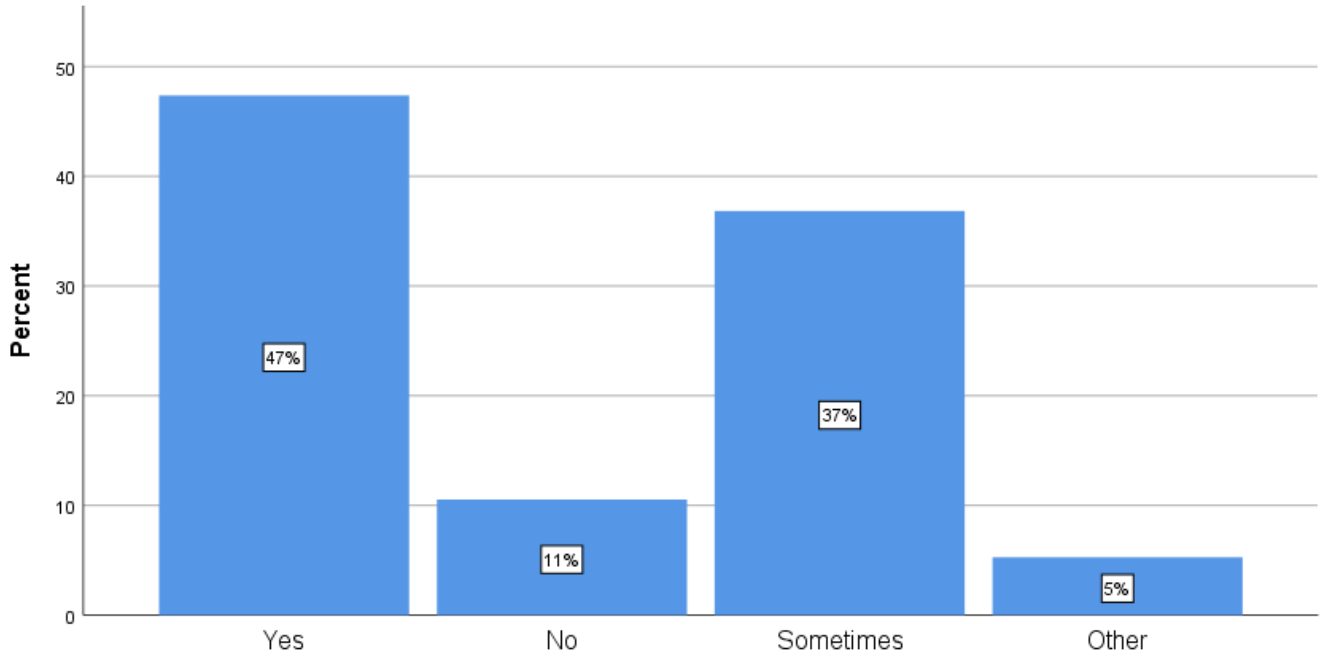
Q35. On what do you base your a priori analysis?



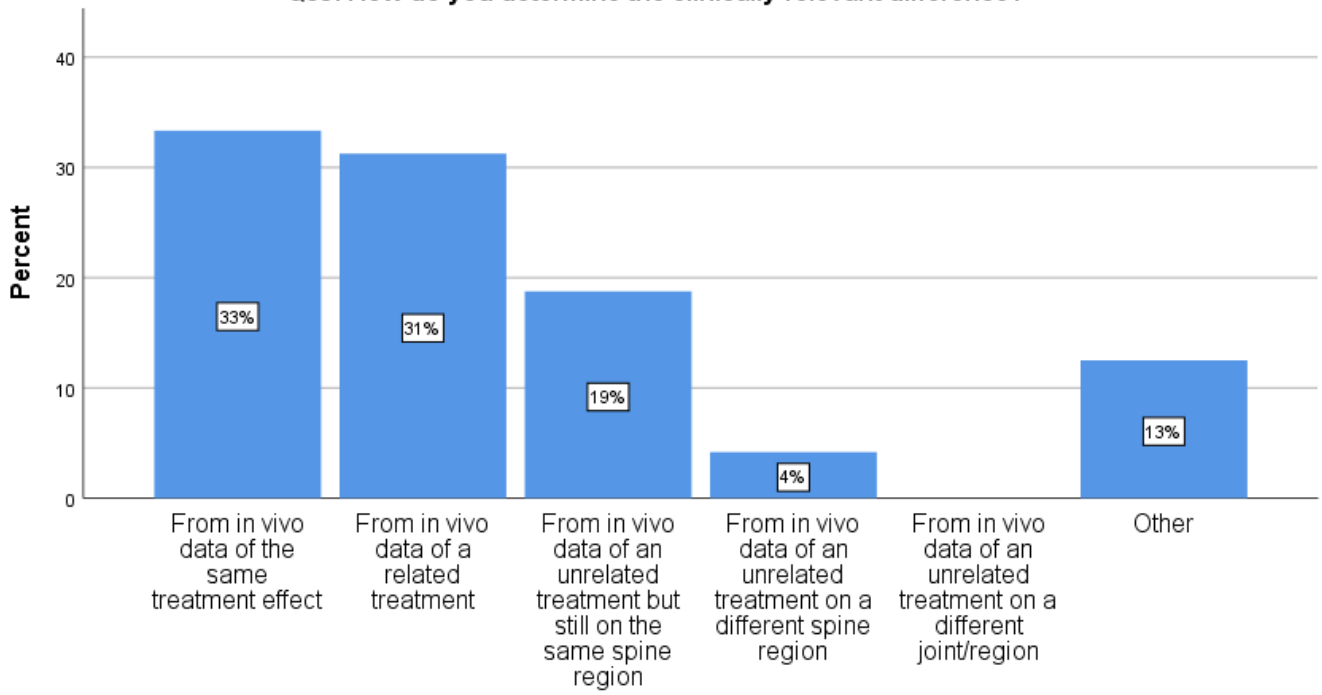

Q36. What sample size do you typically use per treatment group?
Percent
80
60
40
20
0
7%
79%
5%
4%
5%
3-5
6-10
11-20
More than 20
Other


Q37. Do you test for Normality of your data before selecting the appropriate statistical test? (e.g. parametric vs non-parametric statistical analyses.)
Percent
60
40
20
0
66%
7%
25%
2%
Yes
No
Sometimes
Other

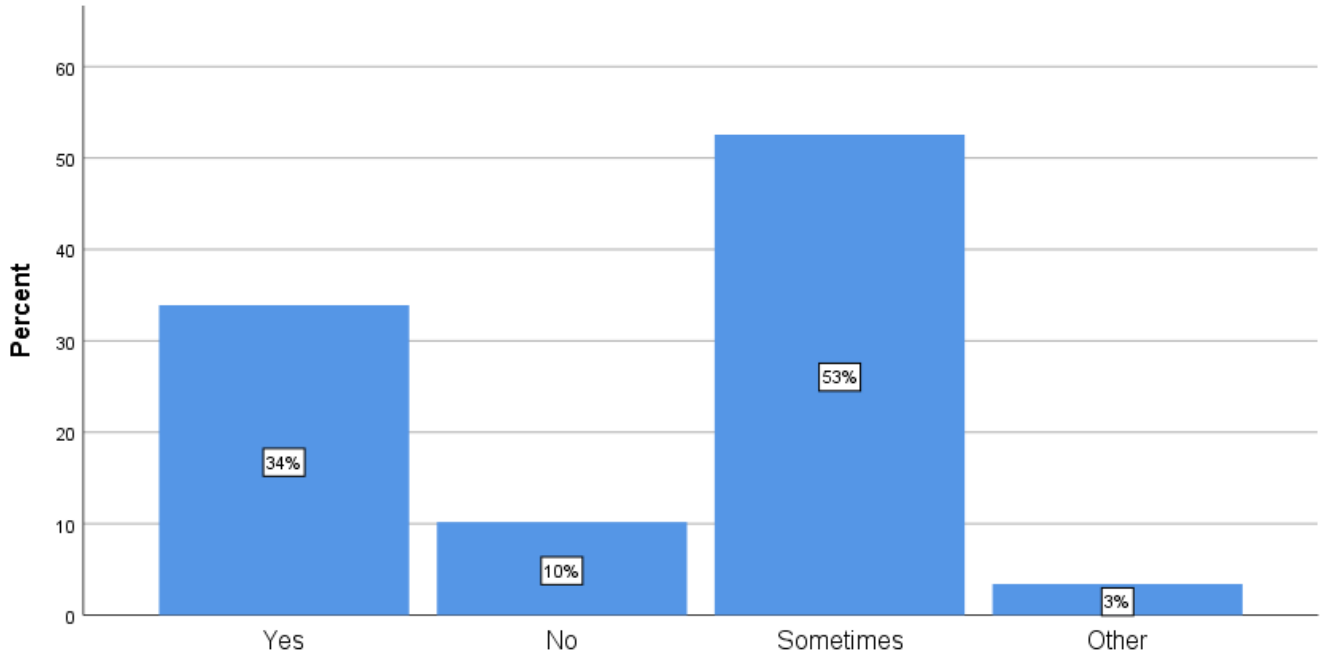
Q38. When analyzing and reporting your data, do you interpret your statistical findings against a clinically-relevant difference between groups?



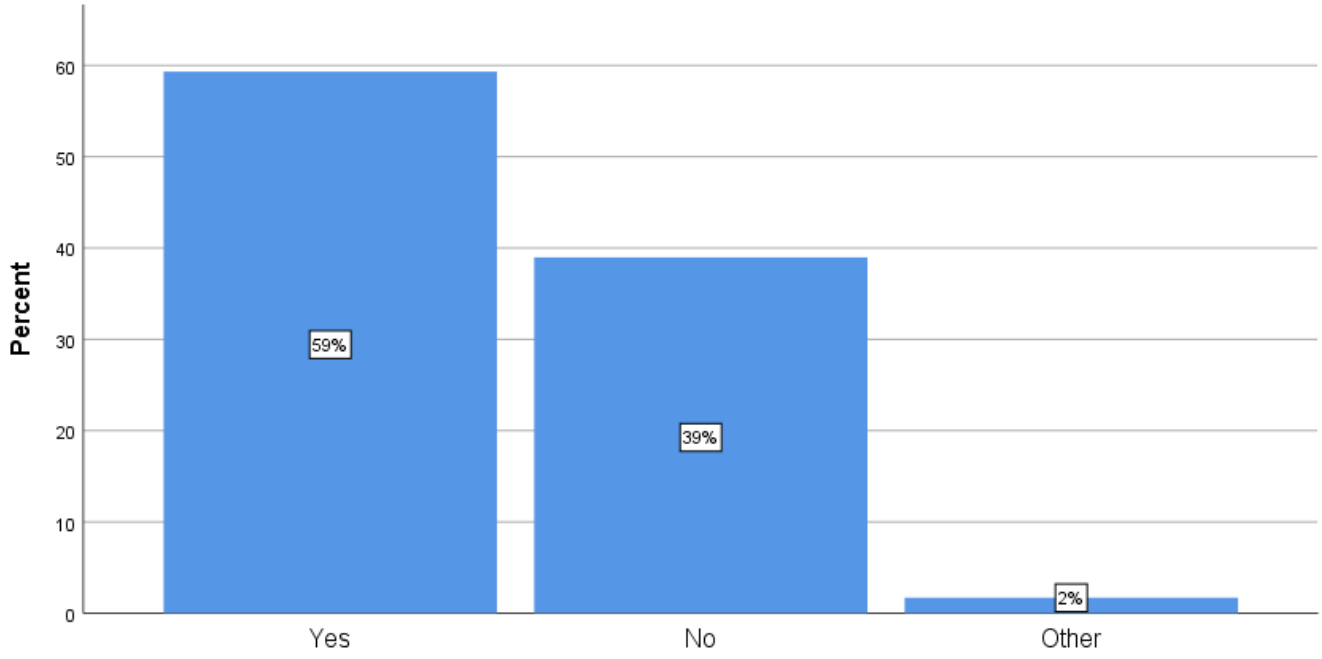
Q39. How do you determine the clinically-relevant difference?



Q40. Do you treat each spinal level (i.e. L23, L45) as separate groups in your statistical analysis?

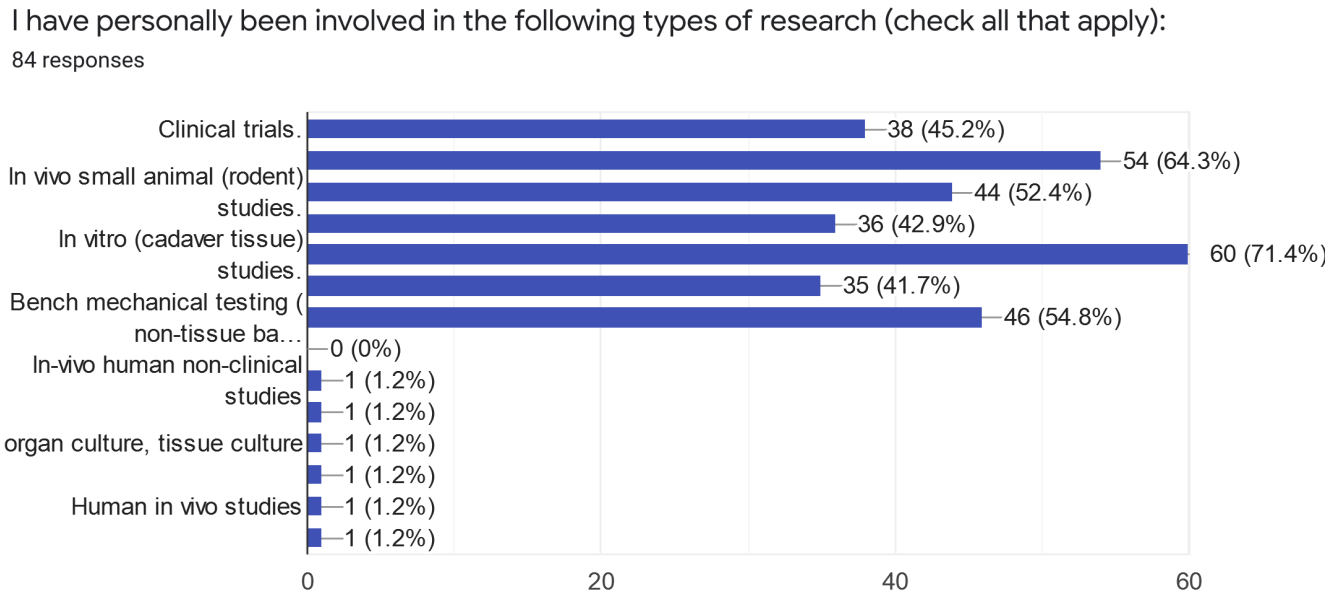


Q41. Have you ever validated your findings by repeating a study, or by collaborating with another lab to repeat your study, or vice versa?



Q42 [General Information] I have personally been involved in the following types of research (check all that apply): (84 responses)

1. Clinical trials.
2. Computer simulations including finite element analysis.
3. In vivo small animal (rodent) studies.
4. In vivo large animal (non-rodent) studies.
5. In vitro (cadaver tissue) studies.
6. In vitro (cell) studies.
7. Bench mechanical testing (non-tissue based, i.e. ASTM).
8. None.
9. Other.



Thank you for taking the time to complete the survey. If you would like to have your name included in the consensus paper as participating in this survey, please include your name and affiliation. (64 responses)