Writing reports

Communicating your results

- Being a statistician means being able to do several things:
  1. Obtain and process the data for analysis
  2. Do a suitable analysis
  3. Check that the analysis was reasonable
  4. Communicate your findings to the world
- The last part is perhaps the most important, because analyses do not exist in isolation; you do an analysis to answer a question, and the answer to the question is the most important thing.
- This is true whether you are in the corporate world, answering to a boss, or in graduate school, where you will eventually have to convince your thesis committee (and, by extension, the academic world) that what you have done is interesting, statistically sound and important.

Reports

- Final step of your process is to write a report. This is a sales job, because you have to convince your readers that what you have done is worth their time reading.
- Writing a report requires good language skills. You cannot become a good statistician without that.
- This is why so many of my questions end "explain briefly". You need to learn to provide a complete and concise explanation of what your results tell you and why.
- Reports are usually structured in a similar way, as shown on next page.

Report structure

- *Introduction*: tell your readers about your problem and what you hope to find out. Provide enough explanation for the reader to know what you're trying to achieve. Can also refer to what other people have done.
- *Methods*: Where the data came from, how collected (describing technology used, if any). Scientific people call this "Methods". Also here: describe work to get data into right form.
- *Analysis and results*: Not enough to *give* analysis; have to *explain* what you are doing and what made you do it. Describe results in matter-of-fact way (opinions in the next section).
- *Conclusions*: What does analysis tell you about your problem? Place results in context. Offer (supported) opinions about what the results mean, to you and the world.

A typical journal article

http://jap.physiology.org/content/100/3/839

Effect of low-repetition jump training on bone mineral density in young women

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Title and authors, with journal and page numbers, so that you have everything you need to refer to it.

Abstract

Journal articles typically begin with Abstract that summarizes question and gives highlights of results and conclusion, and tells you whether paper is worth your while to read.

Abstract

The hypothesis of the present study was that low-repetition and high-impact training of 10 maximum vertical jumps/day, 3 times/wk would be effective for improving bone mineral density (BMD) in ordinary young women. Thirty-six female college students, with mean age, height, and weight of 20.7 ± 0.7 yr, 158.9 ± 4.6 cm, and 50.4 ± 5.5 kg, respectively, were randomly divided into two groups: jump training and a control group. After the 6 mo of maximum vertical jumping exercise intervention, BMD in the femoral neck region significantly increased in the jump group from the baseline (0.984 ± 0.081 vs. 1.010 ± 0.080 mg/cm^2; $P < 0.01$), although there was no significant change in the control group (0.985 ± 0.0143 vs. 0.974 ± 0.134 mg/cm^2). And also lumbar spine (L_{2-4}) BMD significantly increased in the jump training group from the baseline (0.991 ± 0.115 vs. 1.015 ± 0.113 mg/cm^2; $P < 0.01$), whereas no significant change was observed in the control group (1.007 ± 0.113 vs. 1.013 ± 0.110 mg/cm^2). No significant interactions were observed at other measurement sites, Ward's triangle, greater trochanter, and total hip BMD. Calcium intakes and accelometry-determined physical daily activity showed no significant difference between the two groups. From the results of the present study, low-repetition and high-impact jumps enhanced BMD at the specific bone sites in young women who had almost reached the age of peak bone mass.

Introduction

PHYSICAL ACTIVITY MAY PLAY an important role in maximizing bone mass during childhood and may have long-lasting benefits on bone health. Because peak bone mass is thought to be attained by the end of the third decade, the early adult years may be the final opportunity for its augmentation (**13**). Skeletal unloading, such as long bed rest, immobilization, and microgravity environment, lead to bone loss, whereas the positive effects of physical exercise on bone mass is generally acknowledged. It has been shown that dynamic loading is more effective for increasing bone mineral density (BMD) than static loading (**15**). Furthermore, the strain rate is more important than the number of loading trials (**22**).

Prepubescent children (7.5–8.2 yr) who have not yet reached their peak bone mass have shown significant development in lumbar spine bone mass by 100 two-footed drop landings off of a 61-cm-high box 3 times/wk compared with a randomized control group (**6**). Bassey and Ramsdale (**1**) found a significant increase in femoral BMD after 6 mo of 50 jumps daily among premenopausal

Introduction begins with plain-English first sentence. The numbers in brackets are references to what other people have said.

Materials and methods

MATERIALS AND METHODS

Subjects and groups.

One hundred twenty-eight female college students with experience in weighted food records were asked to take part in this study, and 48 students volunteered to participate. The subjects completed the questionnaire containing information about menstrual cycle, pregnancy, past and current physical activity, smoking habit, as well as background information, including history of bone diseases, medication use, and bone fracture. The entry criteria for subjects were eumenorrheic, nonpregnant, no oral medication, nonsmoker, no regular high-impact training, with no medical or surgical problems likely to affect bone metabolism or providing contraindications to exercise. Six subjects were excluded because they had regularly engaged in high-impact sports such as volleyball, basketball, and tennis in the last 5 yr.

Forty-two subjects were randomly divided into two groups, jump training or a control group. In compliance with the university's Institutional Review Board policy, the purpose and all experimental procedures were explained, and written, informed consent was then obtained from each subject. The study was approved by the local health research review board. The subjects were permitted to withdraw at any time for any reason. Bone measurements were conducted at initial baseline and

The subjects. Experiments on humans require “ethical approval”.

Taking measurements

BMD and deoxypyridinoline measurements.

Bone mineral density (g/cm^2) was assessed, using dual-energy X-ray absorptiometry (ALOKA, DCS-3000), in the lumbar spine (L2–4, anterior-posterior view) and the right proximal femur. The femoral neck, Ward's triangle, and greater trochanter of the proximal femur were selected for analysis according to the manufacturer's software. The same radiographer made the initial and final dual-energy X-ray absorptiometry measurements, and the groups (jumping or control) were blinded.

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Maximum vertical jump and ground reaction force.

Maximum vertical jump height was measured by a jump height measuring device (Takei Scientific Instruments, Jump-MD) in both the pre- and postexercise program. At both visits for measuring jump height, subjects jumped vertically at least twice with maximum voluntary effort, and the best performance was recorded. The subjects stood at the center of the circular thin rubber mat (38 cm in diameter). The jumper attached the height-measuring device to her waist. The jump height measuring device and the circular mat were attached by a rope so that the traveling distance from the standing position to the maximum height reached at waist level could be measured. When the

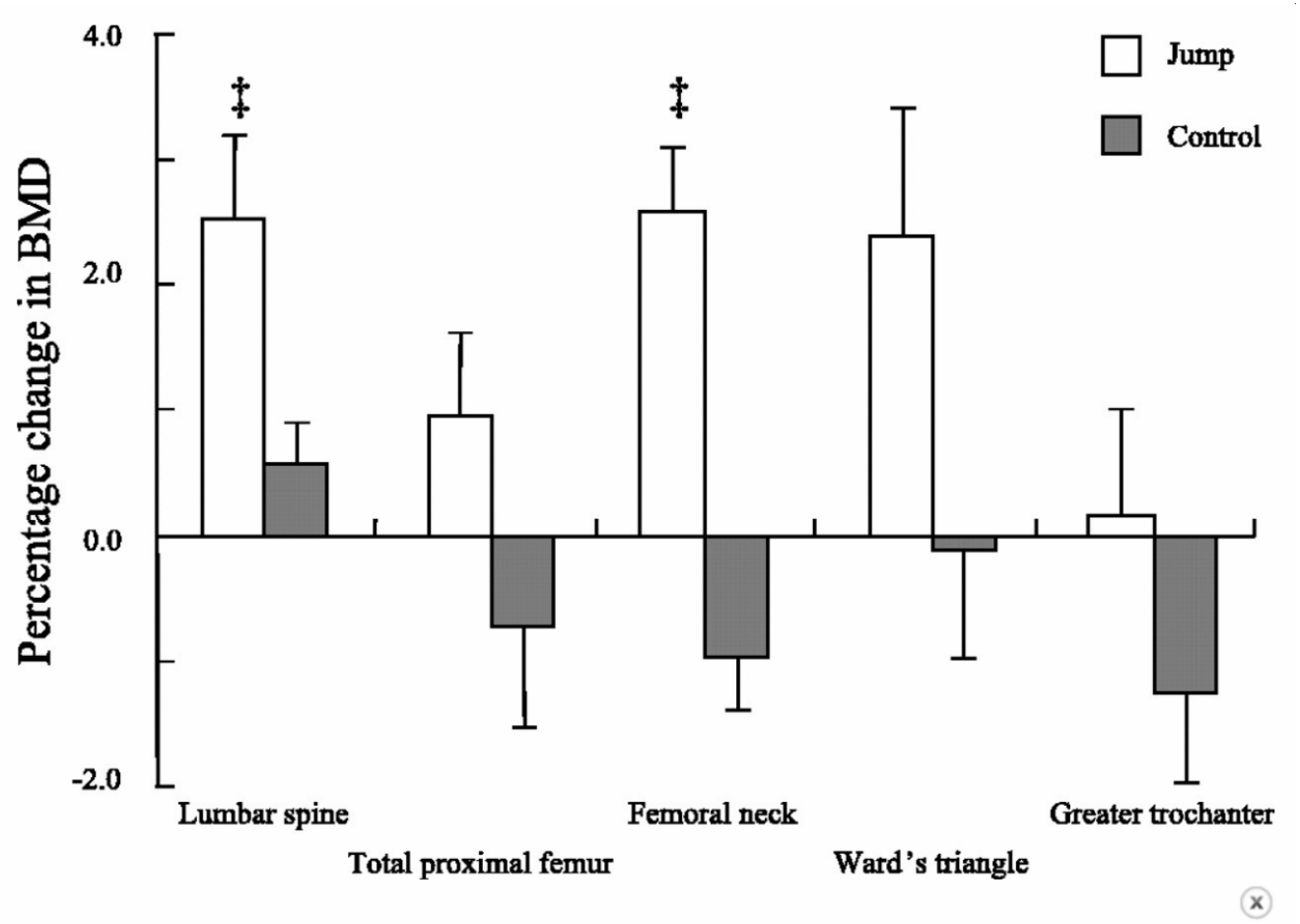
Results (a)

RESULTS

Descriptive statistics indicated that the initial height, age, and movement count were not significantly different between the jump and control groups (**Table 1**). In the jump group, compliance (82%) at jump training was averaged 2.5 times/wk. After the 6 mo of exercise intervention, body weight (BW) was significantly decreased within groups ($P < 0.05$) (**Table 1**). The maximum vertical jump height was significantly improved within groups ($P < 0.05$) (**Table 1**). The average vertical jump height with the same measuring method in the similar age group among Japanese women was 41.0–41.8 cm (**17**). Calcium intake and urinary DPD showed no significant differences between and within groups (**Table 1**).

…noting that the two groups were not significantly different before the study, but changed in important respects over time. Results also shown in table.

Results (b)



Graph showing that bone mass density has changed greatly as a result of the jumping. (Graphs are always good.)

Conclusions (selected) 1/2

DISCUSSION

The most important observation made in the present study was that jump training of 10 jumps/day, 30 jumps/wk significantly increased BMD at the femoral neck ($P < 0.05$), whereas BMD in the control group remained unchanged after 6 mo of exercise intervention. Other investigators have shown that loading with many repetitions at one time had a relatively small additional effect on bones compared with loading of only 10–40 repetitions (**23**, **26**). After many repetitions of mechanical loading on bones, the mechanosensor might show decreased sensitivity (**19**, **20**). Thus its effectiveness as a bone stimulus would appear similar even with fewer repetitions. The loading interval may be another important factor associated with mechanosensor sensitivity (**20**). A high

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Our findings are in agreement with those of Kohrt et al. (**12**), who observed a positive high-impact loading effect on femoral neck BMD in postmenopausal women. The training program involved

Conclusions 2/2

There are, however, some limitations of the present study. First, although an important issue, our study did not measure strain in the proximal femur during the maximum vertical jump. Bassey et al. (3) measured the compressive axial forces in an instrumented massive femoral implant and

Note use of (relatively) plain English, description of most important findings, comparisons to other work, and admission of limitations.

References to other work (some)

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6. ↵ Fuchs RK**, Bauer JJ, and Snow CM.** Jumping improves hip and lumbar spine bone mass in prepubescent children: a randomised controlled trial. *J Bone Miner Res* **16**: 148–156 2001. **CrossRef PubMed Web of Science**

Reproducibility

- The paper we just looked at contained a lot of information.
- Partly, this was to show that the researchers followed proper procedure (important with human subjects).
- Also allows anyone to do analysis on same data and get same results (reproducible).
- Allows anyone to follow same procedure on own data and see if results same (replication).
- As statisticians, we need our own reports to be reproducible, and to be able to replicate them on different data.
- Strategy for this: write reports so that they include the code and a way of running it.
- This can be done in R (R Markdown in R Notebook).

Why this is better than copy-and-paste

- This seems like more trouble than copying-and-pasting the code and output into a Word document. Why should I do it?
- You are guaranteed to get code and output that matches up. If you copy-and-paste, how do you know you remembered to copy the most recent run of your code? (When you change your code, you have to remember to run it again, and to re-copy the output.)
- Anyone else, or you yourself later, can make the document again from the R Markdown file (and the data files), or run the same code on a new data file. This makes the analysis reproducible. Any procedure that depends on copy-pasting the right thing is not reproducible.
- Bosses have a habit of asking for small changes to a document. You make those small changes in the R Markdown file, knit again, and you have your results with minimal fuss.

Other output formats

- The basic (and fastest) form of output is HTML. This is best for while you're writing the report, or if you want to put it on a web site.
- Word .doc output: when you think you've finished writing (slow). If you want to make changes, edit the R Markdown, close the Word doc and re-knit.
- PDF, via a LaTeX installation such as `tinytex` (R Studio on Jupyter has LaTeX already).
- Presentations of various flavours (makes suitable HTML/PDF out of the R Markdown).

Writing your own report

- A complete report of an analysis has (at least) three parts:
  - **Introduction**, where you talk about the context of your data, where it came from, and what you are hoping to learn
    - you might also have a Literature Review where you talk about work that other people have done
  - **Analysis**, where you describe the steps you took to get the data into shape for your analysis, what analysis you did *and why*, and your assessment of the assumptions for your analysis.
  - **Conclusions**, where you summarize what you learned about your data, and the implications for the world outside your data set.
    - if you have a Literature Review, you probably also want to discuss how your results are consistent (or inconsistent) with the literature.
- Only a small part of this is actually doing Statistics. More of it is explanation, using your language skills. Much of the rest is typically getting the data into shape to do your chosen analysis.