Author's response to reviews

Title: Adolescent postural response to backpack carrying conditions: a randomised controlled experimental study

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PDF covering letter
Response to reviewers

Dear Editor,

Thank you for allowing us the opportunity to respond to Dr David Pascoe’s criticisms of our paper Manuscript ID 17067667267959

Adolescent postural response to backpack carrying conditions: a randomised controlled experimental study.

We would like to thank Dr Pascoe for the time and trouble that he took in providing the reviewer’s comments. His comments make a valuable contribution to our investigation, and to our confidence that our work contributes to knowledge about adolescent postural response to loads. We have amended our paper according to his comments and respond to them all in this letter. We enclose the track changes version of our amended paper and also the corrected version. We trust that these changes will make our paper suitable for publication in your journal in the near future.

Major comments / Concerns

In his first comment, Dr Pascoe makes a valid point regarding the lack of experimental evidence about the relationship between posture and pain. There is a limited amount of high quality information in this area for adults but almost none for adolescents, and thus measurement of posture, and how to relate it to pain continues to frustrate researchers interested in this area. Most work on posture and backpack loads for adolescents involves small samples, different types of measurement of posture, different experimental conditions and different methods of analysing and reporting the posture data.

The aim behind our work has been to attempt to establish whether the regular concern regarding heavy school bag loads, expressed in the media and at school council level by parents, teachers and students, had any basis, and whether recommendations could be made regarding appropriate loads and carrying conditions. Our work to date has established that for boys aged 12-13 years (in first year high school) and also boys aged 16-17 years (in final year high school), carrying school backpacks loaded with more than 3.7 kgs is three times more likely to be associated with reports of low back pain than when lighter loads are carried [1]. We have also established that there is 2.5 times the risk of neck pain for boys and girls aged 15-17 years when carrying loads heavier than 3.7 kgs, compared with carrying lighter loads [1,2]. Coupled with the evidence that we have regarding loads and postural response [2], we suspect a cumulative tissue-response to repeated heavy loading. Thus, we believed that we had the grounds on which to conduct an experimental study to assess adolescent postural responses to increasing loads.

Our concerns are founded in the hypothesis that there is a continuum of association between environmental stresses on adolescents, their posture and their reports of pain.
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during their adolescence and on into their adulthood. It is plausible from discussions we have had at Government level and at individual schools in Australia, that there is an acceptance that litigation is just a matter of time (based on plausibility and premise of association) regarding exposure during adolescence to poor working conditions (heavy school bag loads, furniture etc) and spinal pain. These concerns have particularly weight given the high incidence of adult spinal pain and its costs to society [3,4]. Thus it appears important for researchers to continue to work in this area to tease out posture and pain relationships and to propose carefully constructed hypotheses regarding the putative relationship between body response and environmental stresses.

We have been working in the area of posture measurement for over 15 years, in an attempt to define and understand ways in which posture can be measured, and in which it can be related to pain. Professor Trott and I have published separately and together on aspects of adult posture measurement and pain [5-15] – identifying cross-sectional links between these parameters. With other colleagues I have published on adolescent posture and pain, establishing a strong link between head-on-neck posture and weight of school backpack and between back pain and a range of intrinsic and extrinsic factors including backpack weight [1,2,16-18]. We are thus cogniscente of the measurement issues of pain, and how to relate these to posture, given the complex time-series analysis which would be required in order to relate the effect of exposure (posture) to outcome (pain). The link between posture and pain at present is made via Janda and Kendall et al’s work [19-21], where human standing posture is believed to require least physical effort when it is closely aligned with a gravitational axis (a vertical line, usually drawn through, or close to the ankle). The more that standing posture becomes incongruently aligned with the gravitational vertical, the more likely it is that the supporting structures of the spine (muscles, ligaments, joint surfaces and connective tissue) will be put under increasing stress, inducing nociceptive responses in the short term, and/ or sub-acute tissue changes which produce permanent tissue damage and nociceptive responses in the long term [22-25]. The potential for repeated poor postures causing pain in the adult workforce has been well documented [26-30] and it is plausible that repetitive load carriage in backpacks is not only a significant extrinsic factor in poor posture in adolescents, but potentially a cause of spinal pain, if considered in a cumulative sense throughout their adolescence.

If one considers the nine criteria for causality, as described by Hill [31], the putative relationship between posture and pain currently rests on the arguments of:

♦ analogy (with mechanical failure of structural joints when placed under repetitive abnormal loading)
♦ animal and cadaver studies where tissues can fail when placed under increasing loads (refs)
♦ observational studies of putative cause and effect (such as the ones produced by our team, and Dr Pascoe)
♦ plausibility (where standing posture which is not aligned with a gravitational line requires greater tissue activity to maintain the erect body [19-21].

Our response to Dr Pascoe’s second point is linked with the above response. While it is a plausible argument that the body should not attempt to maintain its unloaded alignment with gravity when carrying a load (as made by Dr Pascoe) there is no countering argument about how much postural perturbation is ‘bad’. While our work cannot provide this information,
we believe that by describing postural change from ‘unloaded’ posture, we are quantifying for the first time adolescent standing posture response to loads. This will provide a platform for further research into postural response to load which may provide some more definitive answers regarding how much postural change is ‘too much’.

Dr Pascoe’s third point is a moot one – how best to assess and report postural change. We have chosen to report our work initially in loaded static standing positions in an attempt to carefully refine measurement of posture, and postural change. Our laboratory work with adolescents carrying loads whilst walking (using both 2D and 3D measurement systems) has identified the difficulties of taking and then interpreting measurements of posture change relative to load, and dissociating them from postural response to the gait cycle. These difficulties have also been highlighted by Dr Pascoe and others [22-23,32-40]. By eliminating the gait cycle and observing posture in static standing only, interpretation of postural responses to load was the focus of our investigations, reported in this paper.

We acknowledge that this paper should be a precursor to others which investigate postural change under different load carrying conditions, and using different backpacks. However, our cross-sectional study of 1269 subjects found that of the approximately 1.5 cumulative hours spent carrying their school backpack each day, students stand with the backpack on for approximately 75% of that time (talking in the playground, standing at the bus stop, standing in line in class etc) [1]. Thus standing with a backpack load is a common activity for adolescents in Australia, and one that potentially induces different static postural responses than when they walk with their backpack load. In line with Dr Pascoe’s suggestion, we have amended our language throughout the paper to clarify the nature of the experimental activity.

Minor comments / concerns
1. Title amended to ‘Adolescent standing postural response to backpack loads: a randomised controlled blinded experimental study’. We believe that this is a well designed study, in that it complies with all the requirements as specified by the instructions to authors in the Lancet of an RCT (www.thelancet.com) with at least one set of study participants blinded to the outcome (we believe that photographer and measurer were blinded).

Abstract
1. We have amended the text to refer to poor unloaded posture and spinal pain.
2. We are not sure what is meant by the second point. In all the occupational and epidemiological literature reviewed for our work [for instance 3,4,19-21,24-30], spinal pain is a common term encompassing all tissues related to the spine.
3. We have amended the text by clarifying this statement.
4. We refer to a common design of school backpack and describe this backpack in the Method section.
5. We believe that this study is at least double blind. It was impossible to tell from looking at the subject or from the photographs what load is being carried in the backpack, thus apart from the unloaded photographs, the researcher administering the conditions, the photographer and the digitizer were blinded to the condition being tested. Subjects were questioned throughout the study and could not distinguish the difference between the loads being tested. This would have reflected our experimental conditions, that all loads were held close to the spine in the one position in the backpack, and that the time
between condition administration and photograph was minimal. Our previous research indicates that subjects can most readily distinguish the effect of 5 and 10% body weight loads when they are placed in the posterior compartment of the backpack, not when they are held close to the spine.

6. This has been amended in the text.
7. ANOVA is appropriate for this analysis because we chose only one baseline measure for comparison, that which provided us with the most stringent comparison with loaded conditions.
8. This has been amended in the text.
9. This has been amended in the text.
10. This has been amended in the text to reflect the test procedure – the centre of the backpack. This is important as it would be very difficult to interpret these findings in community settings in terms of centre of mass of the pack.

Background
All the comments in the Background section have been addressed by rewording and clarification of wording (see track changes).

Method
All suggested changes to the text have been incorporated.
Another figure has been added as suggested (figure 1) which outlines the three test positions of the backpack.
The Latin square design allowed for testing of different responses to the order of administration of the backpack test conditions, which would have allowed us to determine in some measure fatigue from testing. The three administrations of the unloaded baseline posture also allowed us to observe differences in postural response which could be attributed to fatigue, or to postural adjustments throughout the testing process. We have deleted this reference.
Our understanding the opportunities for blinding are outlined in the response to the major concerns / criticisms.

Results
We are not concerned that the largest number of refusals to participate came from two specific year levels, as outlined in the Discussion. This is because the Years 9 and 10 subjects were not different in their postural responses from any other year level in the sample.
All other comments are addressed in the revisions in this section.

Discussion
Use of within student experimental parameters (percent of body weight, and position on the spine) was an appropriate way to control for the potential confounding effect of gender and age (of which proxies could be weight and height). We make the point that percent body weight loads, and anatomical positions of the backpack on the spine, are a way of providing standard information on the effect of loads on static posture in a way that can then be individualised to the child. These findings however do not mean that adult information on the effect of posterior loads can be extrapolated to adolescents, because comparisons have not been undertaken that take account of different muscle performance, and posture responses relative to neurological maturation.
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We have removed the section on differences in repeated baseline measures, as on reflection we agree with Dr Pascoe that they may well simply reflect measurement error (which we failed to report) and hence reflect consistency in standing posture whilst not carrying a load.

There is a considerable amount of literature on load carriage in adults, and a lesser amount in adolescents. We have undertaken an extensive review of the literature in the area, and have found much of the research literature limited by small sample size, less than description of intervention, differences in measurement techniques, differences in anatomical landmarks chosen for measurement, and different approaches to amalgamation and analysis of postural data. We have therefore referenced only those studies which we feel have direct relevance to our measurement approach and our experimental approach.

We have amended our text to incorporate suggestions by Dr Pascoe for clearer reading and for greater ease of interpretation.

Conclusion
We have attempted to make more sense of our findings in terms of recommendations, within the constraints of our test procedures.

References for the paper
We have amended the errors in the referencing, including the citing of the availability of our 1998 report on our cross-sectional study. We have included Dr Pascoe’s paper in Ergonomics as it was indeed a relevant reference for our work.

References for this response to reviewer’s comments
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