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Editorial

Welcome to issue 2 (vol 3) of the JST.

Following on from the previous editorial, it is apparent that the sports therapy industry is in need of collaborative research links. Areas which have been identified as pertinent research fields include epidemiological studies and comparative audits of therapy clinics, destinations of graduate therapists, clinical case studies and management of common clinical conditions. In light of this, several pilot studies have commenced and full research reports will be published in the JST in the future. If you would like to join the research community, please contact the editors to discuss your research thoughts.

The professional role of a sports therapist is an ongoing area of discussion amongst sports therapy and related healthcare professionals. The current scope of sport therapy claims to be a unique set of specific roles and responsibilities of which other related professionals supposedly cover in less depth. For instance, first aid provision has been suggested as one defining feature of a sports therapist, compared with other therapists such as physiotherapist. The provision of health care to athletes during sporting activities has been purported to be another distinguishing feature of the sports therapist. Although much debate over this ensues. Needless to say, with the scant quantity of sports therapy specific research on first aid provision, it is a challenge to generalise such comments.

Issue 2 (vol 3) of the JST provides contributions from graduate sports therapists, osteopaths, and sports rehabilitators, exemplifying the journals encouragement of interprofessional alliances. Firstly, lower back pain is an issue amongst both sporting and non-sporting populations, and much research has attempted to find effective management strategies for chronic low back pain sufferers. Interventions such as pilates and core exercises have been piloted. Secondly, innovative interventions for specific back pain populations have also been researched. Power plates and their role for Ankylosing Spondylitis is the focus of one of the manuscripts. Thirdly, injury rates amongst specific sporting populations is an important research question as it shows further justification of the role of sports therapists.

In addition, the next instalment of our 'research methodology' series takes the reader through the quantitative data inputs with quantitative responses. Finally, the manuscript entitled 'Peer assisted learning to enhance confidence in clinical skills for Sport Rehabilitation students' explores the use of peer assisted learning (PAL) as a learning format to enhance students' clinical skills. The results from the study are encouraging, as the participants' confidence in their skills significantly increased.

We invite JST readers to contribute their thoughts about any of the manuscripts in this edition. Inviting scholarly input creates a forum for discussion and a means to connecting with the greater community. In addition, we have a number of text books available for review. We would like to invite readers for book reviews. For further details or comments, please contact the editor.

We sincerely hope you enjoy this edition of the JST.

Yours in health
Robert Di Leva

Original Research

Peer assisted learning to enhance confidence in clinical skills for Sport Rehabilitation students

Monika Lohkamp¹ (PhD, MSc, PT), Hollie Forbes¹ (GSR, CSCS), Katie Small² (PhD, GSR), Angela Clough¹ (MSc, Dip AAPP(Sport), FSOM, PT), Colin Walker-Johnson¹ (GSR)

¹ Department of Sport, Health and Exercise Science, The University of Hull, Hull, HU6 7RX

² School of Sport, University of Cumbria, Carlisle, CA1 2HH

KEY WORDS

Feedback
Deep learning approach
Clinical practice

ABSTRACT

Context: Peer assisted learning (PAL) has been shown to be effective when teaching specific skills during medical education. However, to date there is no evidence available to show that PAL in the form of student led clinical skills practice sessions can improve confidence in a range of previously learned clinical skills.

Objective: To investigate the effect of PAL in the form of clinical skills sessions on subjects' confidence level. The perceived benefits of PAL were evaluated along with the influence of year of study and attendance of the sessions on those aspects.

Design: A repeated measures design was used with pre and post intervention assessment. **Setting:** Clinical Skills laboratory.

Participants: Forty-two 2nd and 3rd year undergraduate BSc (Hons) Sport Rehabilitation students

Intervention: Participants practiced a range of previously learnt clinic skills in student led sessions in groups of 3 or 4. They decided which skill they want to practice and via role play provided each other with constructive feedback.

Main outcome measure: Score from Sport Rehabilitation Peer assisted Learning Survey (SpoRe-PALS).

Results: Confidence in clinical skills significantly increased ($p < 0.05$) after the intervention. Year 2 participants and participants with high attendance benefitted most from the clinical skills sessions. The perceived benefit and preferences of format of the sessions did not significantly change after the intervention.

Conclusion: PAL can increase confidence in clinical skills, however, it cannot replace formal teaching of skills. Participants prefer feedback from their supervisors compared to their peers therefore in future participants could be taught how to provide constructive and effective feedback prior to participating in those clinical skills sessions.

Introduction:

Sport Rehabilitation is a UK based graduate profession specialised in musculoskeletal injury management and exercise based rehabilitation (BASRaT 2009) and is one of several sport related allied health professions. A major part of the 3 year undergraduate course is the acquisition of clinical skills to appropriately assess and treat musculoskeletal injuries. It has been suggested that to effectively acquire clinical skills, students need to actively participate in learning rather than taking the information in passively via lectures (Weidner and Popp 2007; DeClute and Ladyhewsky 1993). Participants

from a previous study also felt that hands-on experiences are important to acquire specific clinical skills (Mensch and Ennis 2002).

It has been reported that collaborative learning of students is not utilised enough to encourage active learning (DeClute and Ladyhewsky 1993). In response to this, Peer assisted learning (PAL) has been investigated by several researchers (Henning, Weidner and Marty 2008; Burke et al. 2007; Nikendei et al. 2009; Weyrich et al. 2009; Henning, Weidner and Jones 2006) to see if this way of teaching can be utilised to encourage active and independent learning. PAL is

defined as “the development of knowledge and skill through active help and support among status equals or matched companions” (Topping 1998) with the aim of encouraging active collaborative learning, and developing transferable skills such as confidence building and team work (Graham, Burke and Field 2008). Henning, Weidner and Marty (2008) claimed that PAL can occur intentionally implementing structured learning sessions or unintentionally by practicing together in peer groups. In the area of medicine, research investigating the effectiveness of PAL has been carried out predominantly focusing on acquiring or improving one or two very specific techniques or skills (Weidner and Popp 2007; Peets et al. 2009; Burke et al. 2007) but with little applied research into its application to improve several previously learnt skills.

Previous studies in related vocational courses have shown that clinical skill of medical students significantly improved when PAL was implemented as additional training (Burke et al. 2007; Nikendei et al. 2009; Weyrich et al. 2009). These studies trained higher level students to become an educator for lower level students, which is one of the recommendations for implementing PAL (Wadoodi and Crosby 2002). Furthermore, Peets et al. (2009) implemented a PAL model where one student was a facilitator for case study discussions and clinical skills practice. Their findings showed that the students who were allocated to be the facilitator prepared more for the session and improved their knowledge compared to other members of the group (Peets et al. 2009). This indicates that not only do the practicing members of the group benefit from PAL but also those that they are passing on knowledge and facilitating during these sessions. Investigating the unintentional form of PAL, a survey showed that 66% of athletic training students practiced clinical skills together which can be seen as a less organised form of PAL (Henning, Weidner and Jones 2006). The students in this survey claimed that they might not have learnt a specific skill during the practice but they benefitted in terms of increasing knowledge, understanding or technique of previously acquired skills from working with peers (Henning, Weidner and Jones 2006). Other positive findings when PAL was implemented were that greater discussion between students occurred which may not have taken place when staff members were present (Weyrich et al. 2009), students were less anxious to perform skills in front of peers than in front of tutors (Henning, Weidner and Jones 2006), they showed increased confidence (Burke et al. 2007), enhancement of collaboration and clinical skills and were less embarrassed and felt less pressure when asking questions (Weidner and Popp 2007). Ginsburg-Block et al. (2006) even went so far to say that PAL interventions which focus on academic study could improve social and self concept outcomes. However, it must be noted that their review concentrated largely on high school students.

To date most studies have focused on the implementation of PAL in medical education (DeClute and Ladyshevsky 1993; Peets et al. 2009; Burke et al. 2007; Weyrich et al. 2009) and only one study has looked at the effectiveness of PAL in the clinical setting of Athletic training, another sport related allied health profession (Weidner and Popp 2007). This study investigated how competently a wrist assessment was performed before and after intervention of either PAL or sessions with approved clinical instructors. They did not find a significant difference in performing the skills between both groups, however, most students of the PAL group experienced other benefits such as collaboration with others or feeling more confident during practicing (Weidner and Popp 2007). Whilst there is transferability of principles in both medical and athletic training education, no study has yet been carried out in undergraduate Sport Rehabilitation programmes in the UK.

The main aim of this study was to identify if PAL in the form of student led clinical skills sessions influenced the participants' confidence in their clinical skills. Other aims were to investigate the perceived benefits of PAL and participants' preferences for the format of the clinical skills sessions and PAL. Further objectives were to investigate if attendance and year group influenced results.

Method:

Design:

The design of the study was a repeated measurement design with a 9 week intervention.

Participants:

The cohort of second (n=35) and third (n=35) year undergraduate Sport Rehabilitation students was invited to take part in the study. Criteria for inclusion was to be a second or third year Sport Rehabilitation student and excluded were those who did not take part in the voluntary clinical skills sessions. None of the students received training on being a tutor or facilitator for teaching clinical skills.

Sport Rehabilitation Peer Assisted Learning Survey (SpoRe-PALS):

A questionnaire was designed (see Appendix 1 for the full questionnaire) to evaluate the participants' clinical reasoning skills which was partly based on the questionnaire (AT-PALS) by Henning et al. (2006). The questionnaire was divided into four sections: 1. Demographics (3 questions), 2. Clinical Benefits of Peer assisted Learning (26 questions), 3. Perceived benefits of Peer Assisted Learning (17 questions), 4. Student preferences for Peer Assisted Learning (10 questions). The

questions from Section 2 (confidence in clinical skills) were developed by an expert panel comprising academic staff, clinicians and students to ensure face validity. All questions from Section 3 (Perceived benefits of PAL) and most questions from Section 4 (Student preference for PAL) were taken from the AT-PALS. The additional questions for section 4 were developed by the same expert panel as those for Section 2.

The reliability of the SpoRe-PALS was evaluated by asking 2nd and 3rd year students who did not take part in the main study to complete it at baseline and after two weeks.

All questions were answered on a 5-point Likert scale with the following descriptors: Strongly disagree, disagree, uncertain, agree, strongly agree.

Procedure:

Ethical approval for the study was granted by the Departmental Ethics committee. All participants read an information sheet, had the opportunity to ask questions and signed a consent form prior to taking part in the study.

At start of term participants of the main study were asked to complete the SpoRe-PALS. They then took part in their normal degree programme with additional clinical skills sessions once a week for 90 min. After 9 weeks participants completed the questionnaire again.

The clinical skills sessions were not part of the official curriculum and participation in these sessions was voluntarily. Subjects who decided to take part were encouraged to attend all sessions during the semester and at each session an attendance register was taken. Participants were randomly allocated to small groups ($n=4-5$) including a mixture of second and third year students. The sessions were student-led and participants decided prior to the sessions what they would like to practice during the 90 min (for example musculoskeletal assessments of different areas of the body). One participant would take the role as a client, one would be the Sport Rehabilitator and the others would observe, evaluate and provide feedback. Participants were instructed that feedback should focus on clinical anatomy, taking subjective history, practical assessment and technique, management/treatment plan, and professional skills and were encouraged that feedback should be constructive and the whole group should contribute. A member of staff was present during the clinical skills sessions to facilitate and help if requested by participants; otherwise they would stay in the background.

Statistical analysis:

A numeric value was allocated to each response as following: Strongly disagree = 1, disagree = 2, uncertain = 3, agree = 4, strongly agree = 5. Considering the different content of the different sections of the questionnaire, no overall score was calculated but scores for Section 2, 3 and 4 separately. Analysis of the scores for Section 2, 3, and 4 was done for all participants as well as each year group separately. Further analysis looked at the influence of attendance where participants were divided into a high attendance ($>50\%$) and low attendance ($\leq 50\%$) group regardless of year of study.

To establish reliability of the SpoRe-PALS, the Intraclass correlation coefficient (2,1) was calculated using scores from each section of the questionnaire. An ICC < 0.75 was defined as poor and ICC > 0.75 was good according to Portney and Watkins (1993).

The Kolomogorov Smirnov test showed that the scores from the pre and post intervention results for each section were normally distributed ($p > 0.05$). Results from all participants before and after intervention were tested for significant differences using a dependent t-test. For analysing influence of year group and attendance a 2-way mixed model ANOVA was applied with a Sidak post-hoc analysis.

All tests were carried out using the Statistical Package for Social Sciences (SPSS), version 16.0 and the level of significance was set to $\alpha < 0.05$.

Results:

From the 47 participants who were approached to complete the SpoRe-PALS for the reliability analysis, results from 36 students (mean $\pm$ SD age: 21 ± 2.1 years) were included in the analysis. Five were not included due to missing information on the questionnaire and six participants only completed the SpoRe-PALS on only one occasion.

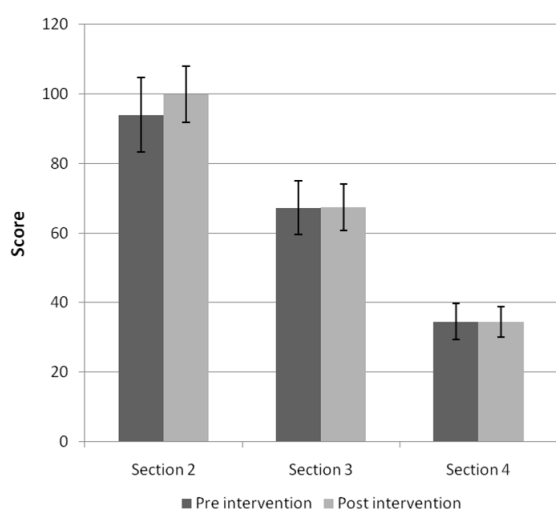
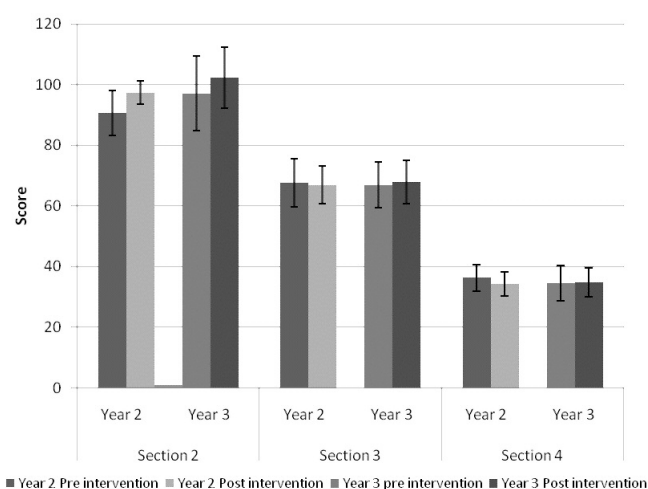
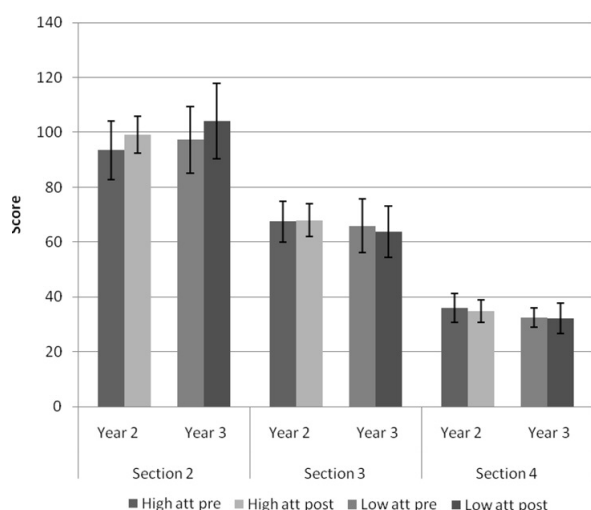
The ICC for the total score of the questionnaire was 0.94 with ICC = 0.89 for Section 2 (confidence in clinical skills), ICC = 0.77 for Section 3 (perceived benefits of PAL) and ICC = 0.77 for Section 4 (student preference for PAL).

From the 70 available participants for the main study 53 completed the questionnaire at the start of the intervention and 42 after the intervention time. Results from the 42 participants were used for further analysis. Demographic information of participants is available in Table 1.

The mean $\pm$ Standard deviation (SD) for the scores of all participants is presented in Figure 1. The paired t-test showed that for all participants the difference between pre and post

Table 1: Participant demographics

	All participant (n=42)	Year 2 students (n=20)	Year 3 students (n=22)	High attendance (n= 36)	Low attendance (n= 6)
Age (mean $\pm$ SD; range)	20.4 $\pm$ 1.6 years (19.0 – 28.0 years)	19.9 $\pm$ 1.2 years (19.0 – 23.0 years)	21.0 $\pm$ 1.8 years (20.0 – 28.0 years)	20.2 $\pm$ 1.1 years (19.0 – 23.0 years)	21.7 $\pm$ 3.3 years (19.0 – 28.0 years)
Male	24	12	12	20	4
Female	18	8	10	16	2
Attendance (average)	70.53%	70.05%	71.01%	76.54%	31.48%

**Figure 1:** Mean $\pm$ Standard deviation of scores for all participants**Figure 2:** Mean $\pm$ Standard deviation of scores for Year 2 and Year 3 participants**Figure 3:** Mean $\pm$ Standard deviation of scores for participants with high and low attendance

High att pre = high attendance pre intervention
 High att post = high attendance post intervention
 Low att pre = low attendance pre intervention
 Low att post = low attendance post intervention

intervention score for Section 2 was significantly different ($p < 0.001$) with the score being higher by 5.92 after the intervention. The other two sections did not show a significant difference between pre and post intervention score ($p > 0.05$). The mean $\pm$ SD for the scores per year group are illustrated in Figure 2 and those by attendance in Figure 3. The results from the ANOVA for Section 2 showed no interaction effect between year group and time of assessment. There was a significant effect for time ($p < 0.001$) with the post intervention score being higher by 5.97. There was also a significant effect for year group ($p = 0.02$) with the score for year 3 being 5.75 higher. Looking at the interaction between attendance and time of assessment there was not statistically significant interaction ($p > 0.05$) for Section 2. There was a statistically significant effect for the time of assessment ($p = 0.003$; 6.23 higher post intervention) and no significant effect for attendance ($p = 0.24$).

The ANOVA results for Section 3 did not show any significant interaction effect of year group and time point of assessment ($p > 0.05$) or any significant effect for year group ($p > 0.05$) and time point of assessment ($p > 0.05$). There was also no statis-

tically significant interaction effect for time point of assessment and attendance ($p > 0.05$) and no significant effect for time point of assessment ($p > 0.05$) or attendance ($p > 0.05$).

The same results as for Section 3 apply for Section 4 where no statistically significant interaction effects ($p > 0.05$) or effects of the factors (time point of assessment, year group or attendance) were revealed.

Discussion:

The main findings from the present study indicated that participants benefitted from the clinical skills sessions in terms of increased confidence but did not change the perceived benefits or the student preferences for the format of PAL. The confidence in clinical skills improved over time and it was influenced by year of study and attendance of the sessions.

The increased confidence in the clinical skills is in accordance with previous findings by Burke et al. (2007), Nikendei et al. (2009), Field et al. (2007). Despite the fact that the present study did not incorporate trained participant trainers to enhance clinical skills the concept of practicing together with allocated roles seemed to have a positive effect. However, it needs to be considered that PAL does not guarantee that skills are performed and practiced correctly as highlighted by Weidner and Popp (2007). To control for correct techniques, the supervisor would need to take a more involved role and intervene when skills were performed incorrectly and nobody within the group was able to correct the mistake. The supervisors did not have to intervene frequently, although participants were reminded of their presence which consequently might have influenced the dynamics of the practice sessions. However, this role of the supervisor was used as some of the positive aspects of PAL, including reduced anxiety (Henning, Weidner and Marty 2008) and facilitation of discussion among participants (Weyrich et al. 2009) can be impaired by having the supervisor taking a more active role.

Another discussion point is that increased confidence might not imply an increase in objective performance. Previous studies have shown that there is a discrepancy between self-assessment (which increases with confidence) and objective performance measures (Nikendei et al. 2009). Therefore, future studies should not only assess the participants' self reported confidence but also an objective measure of the skills.

Results of the present study showed that Year 2 participants increased their confidence in more questions than Year 3 participants and that those with high attendance benefitted greater than those with low attendance. This increase in confidence in Year 2 participants might not only be due to the

clinical skills sessions but also their exposure to clinical placement which they started at the beginning of the second year in a variety of clinical and sporting settings giving them additional skills and confidence. Year 3 participants would have had more experience and have been on placement before and therefore potentially already gained some confidence and clinical skills practice which did not increase further. Another reason might be that Year 3 participants either did not receive detailed feedback from Year 2 participants or did not value the received feedback. Since this was not explicitly asked in the questionnaire, these suggestions are only speculation. Those with high attendance (independently of year group) benefitted more compared to those with low attendance which would indicate that simply attending the clinical skills sessions had a positive effect.

Interestingly, participants indicated after 9 weeks of clinical skills sessions that they preferred less to practice with their peers than their supervisors. They also thought the feedback from peers was not as detailed as from supervisors although this is to be expected as supervisors have greater clinical experience (Ladyshevsky and Gotjamanos 1997). However, it was interesting to find that participants also reported they would prefer practicing with their supervisors rather than their peers which was previously mentioned by Triggs Nem-schick and Shepard (1996). This may be linked to the quality and format of the feedback received from their peers as no formal training in this aspect was given prior to the study. These results could have been influenced by possible issues with feedback 3rd year participants received from 2nd years as discussed above. In future, participants could receive training on how to effectively give feedback and maybe DVDs of specific techniques could be made available for participants in cases where they are unsure about the techniques.

The results showed no change in certain questions asking about confidence in clinical anatomy, gaining informed consent, asking for contraindications, note taking, red or yellow flag, preparing a home programme, and assessing the return to sport. This may be because during the clinical skills sessions participants focused only on certain skills such as taking a subjective history and practicing musculoskeletal assessment rather than taking the opportunity to practice a range of skills. An approach by participants to include a 'full' role play where they also gained Informed Consent, asked for Contra Indications and explained the pathology, assessment and treatment to clients may have encouraged more comprehensive learning. For future sessions, participants should be encouraged to make the practice scenario as close to real life as possible and include these aspects to increase their confidence and deepen their understanding and learning (Ashwin 2003). Other aspects including designing a home exercise programme or using electrotherapy modalities were not practiced frequently during these sessions therefore no

change could be expected in the level of confidence reported. The specific assessment of return to fitness and sport was covered by lectures and practical sessions which occurred after the clinical skills sessions had finished, therefore participants did not have the basic knowledge in this area and did not focus their practice on this area during the clinical skills sessions.

The reliability of the SpoRe PALS showed to be good for each Section (Portney & Watkins 1993) providing the confidence that the results are reliable. As discussed above, participants were on clinical placement during the time of the study and also during the two weeks between they completed the SpoRe PALS for the reliability assessment. This experience on placement might have influenced their confidence in skills, therefore some variation in the score might have been expected.

One of the issues observed by the authors during the clinical skills sessions was that participants did not sufficiently prepare in advance. They only briefly identified which area of the body they would focus on during the next session and who would take on which role. It was apparent that few participants actually revised the relevant clinical anatomy, pathology, assessment and treatment modalities for the area of the body, again, only focusing on a surface learning approach. We propose that participants are likely to benefit greater and enjoy the sessions with their peers more with better preparation as previously suggested by Weidner and Popp (2007). It needs to be stressed that clinical skills sessions like this should not replace supervisor led sessions as the likelihood of mistakes and incorrect skills/techniques in the initial stages of learning would be too high. However, considering the positive effect of these sessions it should be further discussed how they can be made more effective so that students increase their practical skills without increasing the time pressure of academic staff. This could be achieved through a more formalised PAL programme, integrated into a module assessment would provide a more systematic method of enabling participants to practice specific or general clinical skills (Weidner and Popp 2007; Smith, May and Burke 2007). Other ways could be to train participants better in giving feedback so they can give higher quality feedback to each other and provide other learning material (i.e. DVDs) to further support effective PAL.

Conclusion:

Overall, the clinical skills sessions were reported as a success as participants felt more confident in most skills which were included in the questionnaire and the sessions encouraged them to have additional structured sessions to practice. The format of those sessions could be improved by training participants better in giving constructive and detailed feedback to each other and by providing DVDs showing how the correct technique is applied. Implementing this learning strategy could help participants to develop a deep learning approach as an autonomous learner.

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Original Research

A pilot study to investigate the effects of specific exercise compared to general exercise on lumbo-sacral stability and pain in the chronic low back pain population.

Aaron Caseley B.Ost. PGDip.

Department of Sports Therapy, University College Birmingham, Birmingham, UK

KEY WORDS

Exercise
General
Spinal stabilisation
LBP
CLBP

ABSTRACT

Objective: A pilot study to investigate the effects of specific exercise compared to general exercise on lumbo-sacral stability and pain in the chronic low back pain population.

Design: A between group comparison of two different groups with chronic low back pain with two, one-tailed hypotheses.

Setting: Sutton Physiotherapy, Rose Hill Park, Rose Hill, Sutton, Surrey.

Methods: SE group completed six weeks of specific spinal stabilisation exercise twice per week (n=5). GE group completed six weeks of general exercise twice per week (n=5). Assessments of lumbo-sacral stability, on the right and left sides, using a bio-feedback unit, and visual analogue scales (pain), were carried out prior to and upon completion of intervention.

Subjects: 10 osteopathic patients with chronic low back pain (>3 months).

Results: Due to the small sample size applying inferential statistics was deemed to be inappropriate. Therefore, descriptive statistics were used (median change between the two groups) to identify any discernable trends.

Conclusions: Statistical significance was not tested, due to the small sample size. However, observable trends were identified, with regard to median change in lumbo-sacral stability and pain, between the two groups. Further studies of a larger sample size are recommended.

Introduction

Low Back Pain (LBP), defined as pain located below the scapulae and above the cleft of the buttocks, has reached epidemic proportions in the UK, with an estimated £1.6 billion a year spent on treatment (ARMA, 2004).

Although LBP is usually a self-limiting and benign condition that tends to improve spontaneously in 80-90% of the population, within 2-3 months (Waddell, 1999), recurrence is common (Hides, 2001; Skargren, 1998; Croft et al., 1998; Van der Hoogen et al., 1997).

Due to the multifactorial causes of CLBP, a multidisciplinary approach that addresses the psychological, socioeconomic, and physical aspects of the illness has been advocated

(Wheeler, 1995). Exercise is a modality frequently prescribed for the treatment of CLBP; with the many different general and specific exercise programmes advocated reflecting the role that physical de-conditioning is believed to play in maintaining chronic pain and disability (Byrne et al., 2005; van Tulder, 2001). However, much inter-professional debate into the most efficacious exercise intervention still ensues (Mannion et al., 2001; Nordin & Campello, 1999; Campello et al., 1996; Faas, 1996).

General exercise

The physiological benefits of physical activity have been recognised as an important factor in the prevention and treatment of LBP since 1904 (Nutter, 1988). Research suggests a relationship between physical activity, aerobic fitness and LBP,

with LBP sufferers tending to have reduced physical activity levels and reduced cardiovascular fitness (Cady et al., 1979).

Although it is difficult to determine whether decreased physical activity and cardiovascular deconditioning are causal factors or the consequences of LBP, low impact aerobic exercise seems to improve cardiovascular fitness in this population without risking exacerbation (UK BEAM Trial, 2004; Klaber Moffett et al., 1999; Brennan et al., 1987). However, the exact mechanism by which aerobic exercise affects LBP is less clear (Deyo et al., 1989 & 1998).

Many mechanisms have been postulated for the relief of pain in the LBP population using aerobic exercise. One such mechanism, proposed by Koltyn (2002), demonstrated that pain sensitivity diminished during and following exercise (hypoalgesia). Pain is a significant reason for decreased strength (Brox et al., 1997 & 1993) and proprioception (Safran, 2001) in the LBP population. Results of these studies indicate that hypoalgesia occurred following high intensity exercise, exercise prescribed at a percentage of maximal oxygen uptake (e.g. 60-75%) and exercise based on percentage of maximum heart rate (e.g. 65-75%).

There is little evidence available on the mechanisms responsible for exercise-induced hypoalgesia; involvement of the endogenous opioid and non-opioid systems has received limited support in human research (Koltyn, 2000). However, in 1998, Gotoh et al, demonstrated that endorphin release synthesised during exercise, inhibited substance P secretion in patients with rotator cuff pathology. Substance P is a neuropeptide that potentiates pain messages and has been reported in research into the potential pain generators in LBP (Freemont et al., 1997).

Spinal stabilisation

Spinal stability requires the interaction of three systems;

- i. Passive (the vertebrae, ligaments, fascia and discs).
- ii. Active (the muscles acting on the spine).
- iii. Neural (the central nervous system and nerves controlling muscles) (Panjabi, 1992a).

The most vulnerable area of the spine (the neutral zone) occurs around the neutral position of a spinal segment, where little resistance is offered by the passive structures (Panjabi, 1992b). If decreased passive stability occurs, the active and neural systems can compensate by providing dynamic stability to the spine. However, uncompensated dysfunction will ultimately cause pathology (Panjabi, 1992a).

The San Francisco Spine institute (1989) has been one of the first entities to have promoted dynamic lumbar stabilisation as a therapeutic exercise for rehabilitating individuals with

CLBP. This contemporary approach to the management of LBP, involves re-training the active system to attain adequate dynamic control of lumbar spine forces, thus eliminating repetitive injury to the passive sub-system.

Research into lumbar stabilisation conducted by Richardson et al (1996) identified two deep intrinsic muscles, which they concluded as being primary stabilisers of the Lsp: lumbar multifidus (LM) and transverse abdominis (TrA). Due to both muscles proximity to the Lsp, the orientation of their muscle fibres and the predominance of postural, slow twitch (type 1) muscle fibres (Haggmark and Thorstensson, 1979), it was proposed that these muscles directly influenced the stability of the lumbar and lumbosacral apophyseal joints specifically.

Research also suggested that in the CLBP population, subjects appeared to have greater difficulty in preferentially activating TrA and tended to compensate for this by activating higher levels of Rectus abdominis (RA) (O'Sullivan et al., 1997). Other anomalies of TrA were identified in this population in relation to delayed activation, loss of independent control and increased activation threshold (Radebold et al., 2001 & 2000; Richardson et al., 1999) It was postulated that these abnormal trunk muscle responses correlated to decreased postural control and segmental instability causing shear, compression and torsion through the osseous and ligamentous structures of the Lsp (Radebold et al., 2001; O'Sullivan et al., 1997).

Specific research in support of spinal stabilisation programmes is limited, and this type of intervention does not feature in national and international guidelines for the use of exercise with this population. In recent clinical trials, this type of intervention has proved to be effective in the management of specific sub populations of LBP patients in the short and long term (Hides et al., 2001 & 1996; O' Sullivan et al., 1997). Whilst Byrne (2005), found that this type of exercise modality was the most common exercise therapy prescribed by physiotherapists in Ireland, during treatment of patients with LBP.

Aim of the study

Healthcare professionals such as sports therapists, osteopaths and physiotherapists are frequently consulted by patients with CLBP, and exercise is a common adjunct to treatment recommended, by this profession, for this population group (British School of Osteopathy 2004). Standard 2000 requires healthcare professionals to demonstrate "the ability to assist patients to undertake and become committed to self-care activities including exercise" (General Osteopathic Council 1999, p22). The aim of this study was to evaluate specific stabilising training for a group of participants with CLBP, and to compare this with a control group, also complaining of CLBP, using general exercise.

The objective of this study is:

- i. To investigate if the use of specific exercise is more effective at improving lumbo-sacral stability than general exercise in the CLBP population.
- ii. To ascertain if there is any difference in pain reduction when using specific exercise compared to general exercise.

Definition of terms:

- i. Specific exercise – spinal stabilisation targeting TrA in supine, crook-lying, four-point kneeling, prone and standing, to increase lumbo-sacral stability, as detailed by Richardson et al.,(1999).
- ii. General exercise – low impact cardiovascular exercise (65-75% of participant's maximum heart rate) (Deyo et al., 1989 & 1998; Koltyn, 2002).

Hypotheses:

- i. Spinal stabilisation programmes are more effective at increasing lumbo-sacral stability than general exercise programmes (one tailed hypothesis).
- ii. General exercise will be more effective than specific exercise at reducing participant's subjective levels of pain (one tailed hypothesis).

Method

Subjects/participants

Twelve healthy volunteers, with previously undisclosed histories of CLBP were recruited, via a poster campaign in osteopathic surgeries within a 3-mile radius of Sutton, and provided their informed consent. Each volunteer received an information sheet, which included the confidentiality statement, the option to withdraw at any time and access to a qualified manual therapist in the unlikely event of injury or exacerbation of symptoms. An adherence sheet was provided for participants to record whether or not they had carried out the exercises twice per week for the duration of the study. This study received approval from the BSO Ethics Committee.

Inclusion Criteria: Men and women aged 20-65 years with CLBP (pain > 3 months) with or without radiation to the knee (Van Dillen et al. 1998), capable of completing a 6 week programme of exercise.

Exclusion Criteria: Prior segmental stabilizing training, prior spinal surgery, radiation to the leg or legs with overt neurological signs, pregnancy, known lumbar disc herniation, diagnosed inflammatory joint disease, known severe osteoporosis, or known malignant disease.

Participants were randomised into either of two treatment groups: a stabilising group (SE group) (n = 6) and a control group treated with general exercise (GE group) (n = 6) by a blinded observer.

Two participants (one in the SE group and one in the GE group) were excluded, due to health reasons which made them unsuitable to undertake a 6 week programme of exercise, prior to commencing the intervention. The groups were thus: SE n = 5, GE n = 5. Both participants were excluded from the baseline data (Table 1.).

Table 1. Participants characteristics (n=10)

	SE GROUP (N=5)	GE GROUP (N=5)
Age (year) median (SD)	46.2	46.6
Gender (female/male)	5/0	3/2
Weight (Kg) median (SD)	73.98	81.04
Exercise habits (seldom/weekly)	5/0	3/2
Pain duration > 12 weeks	5	5

The data (table 1) shows the participants in both the GE group and the SE group prior to participation in the study. The average age of both groups was similar. The blinded allocation of participants to groups led to a difference in the male/female ratio between the two groups. The weight of one of the participants in the GE group was 114.5 kg; this skewed the overall weight of this group. However, when comparing individual bodyweights in both groups the difference was minimal.

Procedure

Before and after the intervention, assessments were made. The participants filled out a health locus of control questionnaire for analysis but these were not considered as part of this study. Their bodyweight was recorded and subjective pain levels were measured using a Visual Analogue Scale (VAS) (Huskisson, 1983). The VAS was a 10-cm vertical line, anchored from 'no pain' to 'unbearable pain'. The participants registered the magnitude of pain with a mark on the line.

The examiner, a chartered physiotherapist (CSP No. 073662), then instructed each participant into crook lying, with the spine in neutral and hip flexion set at 45 degrees, using a goniometer. During EMG studies differential activity of TrA was greatest in the supine crook-lying position (Urquhart et al., 2004 & 2002) and this position has been demonstrated to test the ability of the trunk muscles to hold the lumbo-pelvic

region in a steady position (Wohlfahrt et al., 1993; Sahrman, 1987).

The participants were then instructed on how to activate their deep abdominal muscles using standard instructions (table 2): inward movement of the lower abdominal wall (Richardson et al., 1999). When performing each exercise, participants were advised to use "mild" effort, equivalent to a rating of 2 on the Borg scale (Borg, 1982; Richardson et al., 1999). This level of contraction is sufficient to provide muscle stiffness required for joint control (Cholewicki & McGill, 1992; Hoffer & Andreassen, 1981). Whilst doing this the physiotherapist ensured optimal contraction, by palpating the inferior border of the anterior superior iliac spine (ASIS) and then moving 4cm medially, to locate TrA. Once appropriate activation of TrA had been assessed the participant was then asked to maintain this level of contraction and breathe normally. This was done to prevent subjects performing the valsalva manoeuvre, which could potentially skew the results of the test.

Table 2.
Standardised instructions used for the activation of TrA

EXERCISE	INSTRUCTIONS*
Inward movement of the lower abdominal wall	Breathe in and out. Gently and slowly draw in your lower abdomen below your naval, without moving your upper stomach, back or pelvis.

* Participants were also instructed to perform each exercise with 'mild' effort (2 on the Borg scale).

Once this had been practiced and the subject felt confident, a bio-feedback unit (BFU) (Stabilizer, Chattanooga Group Inc.) was placed under the lower lumbar spine, just above the posterior superior iliac spine (PSIS) (see Picture 1). This was done to measure the participant's ability to maintain neutral spine and is consistent with clinical hypotheses, which indicate that activation of TrA is more independent if there is no pelvic or spinal movement (Richardson et al., 1999). The BFU was inflated to 40 mmhg and the participant again instructed to draw in their lower abdomen, whilst maintaining the BFU at 40 mmhg. Inflation of the BFU to a pressure of 40 mmhg has been found clinically appropriate to fill the space between the irregularly shaped Lsp and the firm testing surface, without predisplacing the Lsp from its natural resting position (Richardson et al., 1999).

The participant was then instructed to perform a series of leg-loading exercises (1-5 levels of intensity) (Sahrman, 1987;

White & Sahrman 1994), whilst maintaining the contraction of TrA, breathing normally, and maintaining the BFU at 40 mmhg (see Picture 1). The benefit of using this method of leg loading is that the magnitude of resistance can be easily controlled, and the maintenance of Lsp position can be objectively monitored using the BFU (Sahrman, 1987).

Picture 1. Assessment of lumbo-sacral stability in crook-lying using a BFU. Sahrman's leg-loading exercise level 1 is being demonstrated.



The BFU assesses where movement away from neutral occurs. Posterior pelvic tilt is reflected by an increase in the baseline pressure, whereas anterior pelvic tilt is reflected in a decrease in pressure from the baseline. When the participant was no longer able to maintain a neutral spine, shown by an increased or decreased reading of 4mmHg on the BFU, or their abdominal muscle started to 'dome', indicating activation of higher levels of Rectus abdominis (RA) (O'Sullivan et al., 1997) the test was completed. This protocol was performed 3 times, on right and left sides, to enable a mean distribution to be calculated.

This measurement method has been ratified to clinically identify a known dysfunction of TrA in patients suffering from CLBP (Jull et al., 2000; Hodges et al., 1996) and considered a useful clinical tool to indicate anterolateral abdominal function (Cairns et al., 2000).

Intervention

SE group

The SE group subjects ($n = 5$) underwent a 6-week treatment programme, meeting as a group once a week for 30 minutes, with the researcher, a qualified clinical Pilates instructor (Register of Exercise Professional, advanced level 3 instructor, membership no. R0005522). The participants were taught how to activate and control their deep abdominal muscles (TrA) (Richardson et al., 1999; Richardson et al., 1995). The first phase of the intervention was cognitive and the participants were taught how these muscles act as a stabiliser for the lumbar spine. The importance of re-learning motor control of these muscles was underlined (Jull & Richardson, 2000). The participants were taught how to activate TrA together with relaxed breathing in different positions (e.g. supine, crook-lying, four point kneeling, prone, and standing). The exercises were gradually developed by applying a low load to the muscles through the limbs, in different positions. They were also encouraged to perform a series of three TrA exercises, designed to take 10-15 minutes, at home on one other occasion throughout the week. During the 6-week programme exercises used for assessment purposes were not taught to participants.

GE group

The GE group ($n = 5$) underwent a 6-week programme of general exercise under the supervision of a qualified fitness instructor. Prior to commencing the intervention, each participant's maximum heart rate (MHR) was determined ($220 \text{ MHR} - \text{participant's age}$), and aerobic training thresholds were calculated (65-75% of their MHR). This was done to ensure each participant exercised in an aerobic training zone (Koltyn, 2002; Dick, 1999; Brennan et al., 1987) and to ensure that those who were unfamiliar with exercise, maintained an appropriate intensity of exercise (Dick, 1999). Participants were then instructed in the use of the cardiovascular

machines (treadmill, bicycle (stationary) and cross-trainer) and advised to maintain their heart rates within previously prescribed limits for a duration of 30 mins, twice per week. All cardiovascular machines used in this study were manufactured by Matrix, model No. MX – T5X and had heart rate monitors in-built. Participants were advised prior to commencing the trial that they should avoid exercises which exacerbated their current LBP, and if symptoms did persist they should return to their osteopaths.

Measurement

A pilot study was conducted to ensure familiarity with setting up crook-lying, to standardise the protocol for assessment and to test the intra-examiner reliability of the assessment method. All measurements were recorded by a chartered physiotherapist to ensure no bias. The intraclass correlation co-efficient for measuring lumbosacral stability using a BFU was .00. This indicates excellent reliability and precision for these measurements.

Analysis of data

Due to the small sample size, it was deemed inappropriate to use inferential statistics to demonstrate a statistically significant change. Therefore, descriptive statistics (median change) were applied to identify any discernable trends between the two groups in terms of lumbo-sacral stability and pain.

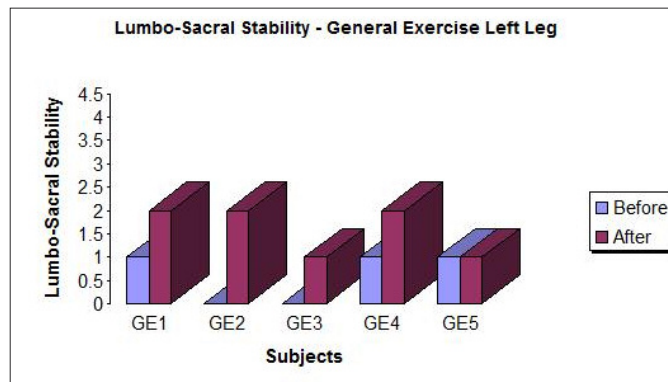
Results

All ten participants ($n=5$, GE; $n=5$ SE) completed the study, with a 100% adherence. During the course of the study, one participant suffered a fall at home and owing to the participant's subjective level of pain (VAS) and in accordance with the well documented effect of pain on strength (Brox et al 1997 & 1993), was subsequently excluded from the final sample. The final sample was therefore distributed as in table 3.

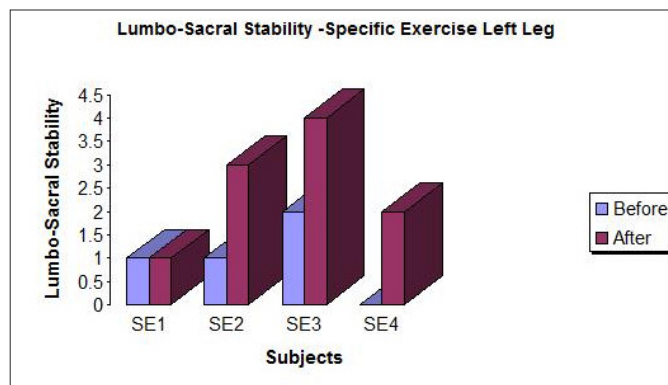
Table 3. Final sample analysis.

	NO. SUBJECTS	GENDER (FEMALE/MALE)	% ADHERENCE	MEDIAN LS STABILITY PRIOR	MEDIAN LS STABILITY AFTER	MEDIAN LS STABILITY CHANGE
GE group Ls stability (left)	5	3/2	100	1	2	1
SE group Ls stability (left)	4	4/0	100	1	2.5	2
GE Group Ls stability (right)	5	3/2	100	1	1	0
SE group Ls stability (right)	4	4/0	100	1	2	1

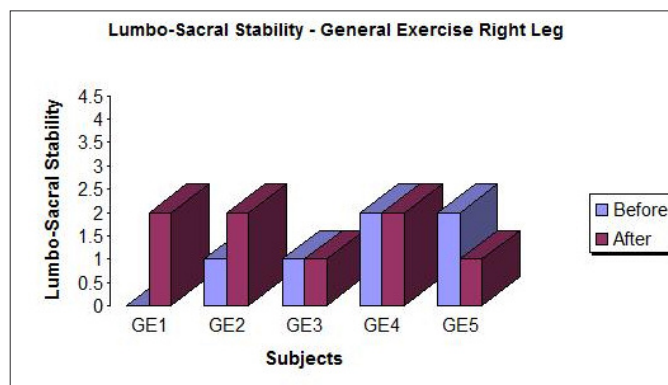
This data (table 3) shows that the median change in lumbo-sacral stability over the period was higher in the SE group than the GE group on both the left and right sides.



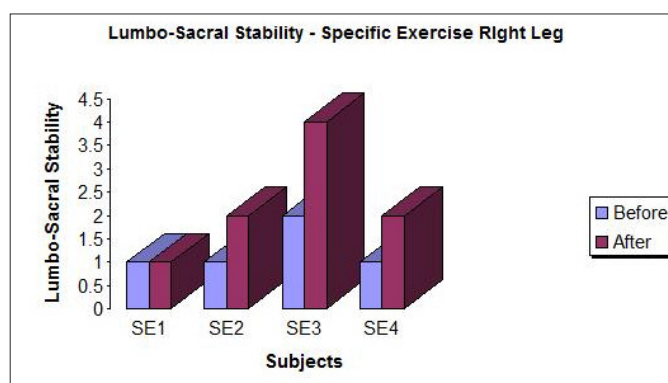
Graph 1.



Graph 2.



Graph 3.



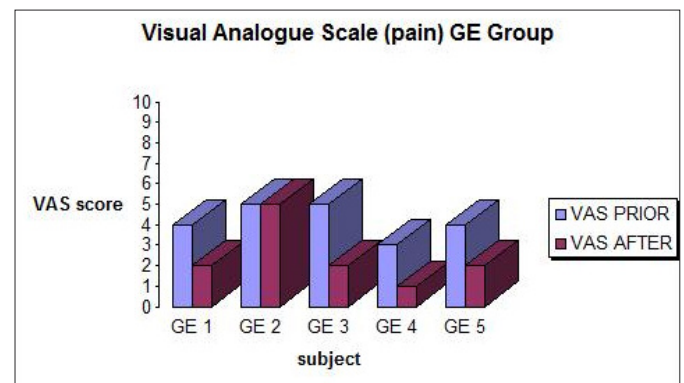
Graph 4.

Graphs 1-4 (left) demonstrate lumbo-sacral stability in the GE and SE groups on both the left and right legs before and after intervention. For example, referring to graph 4, participant SE 2 had a lumbo-sacral stability of 1 prior to intervention, which increased to 2 after intervention, on the right leg.

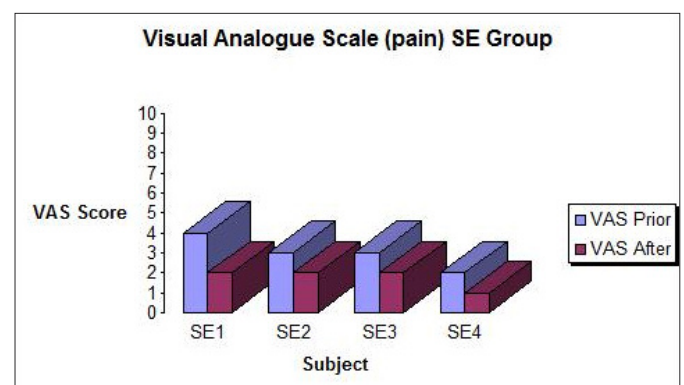
Table 4. Sample analysis of VAS scores

	NO. SUBJECTS	MEDIAN VAS PRIOR	MEDIAN VAS AFTER	MEDIAN VAS CHANGE
GE Group VAS (pain)	5	4	2	2
SE Group VAS (Pain)	4	3	2	1

This data (table 4) shows the median change in the VAS (pain) scores over the period were higher in the GE group than the SE group.



Graph 5.



Graph 6.

Graph 5 & 6 (above) demonstrate the change in Visual Analogue Scale (pain) for both the GE and SE groups before and after intervention. For example referring to graph 6 (above) participant SE1, had a VAS score of 4 prior to intervention and 2 after intervention.

Discussion

The first hypothesis of this study was that specific exercise is more effective than general exercise at increasing lumbo-sacral stability in a group of participants with CLBP.

The median change in lumbo-sacral stability was greater in the SE group compared to the GE group (table 3). This discernable trend, although statistically insignificant, is in line with the findings of previous research that specific exercise is effective at improving the lumbo-sacral stability of specific sub-groups of the LBP population (Hides et al., 2001; O'Sullivan et al., 2000).

The second hypothesis of this study was that general exercise was more effective than specific exercise at reducing subjective levels of pain in a group of participants with CLBP.

In both the GE and the SE group, participants (GE group n=4; SE group n=3) reported a subjective decrease in pain levels during the duration of the study (table 4). The median change in participants'VAS scores was higher in the GE group compared to the SE group. The observable trend in pain reduction in the GE group is supported by Koltyn's theories into exercise-induced hypoalgesia, reviewed earlier in this study (Koltyn 2000 & 2002).

Several methodological issues require consideration in this study and for those considering future research using these protocols. Due to the difficulty found in recruiting participants and the resulting small sample size, it was decided to treat this as a pilot study. The participants for this study were osteopathic patients who lived within a 3-mile radius of Sutton. Difficulties lay in recruitment from osteopathic clinics, as the research was reliant upon the referral of patients by busy, practicing osteopaths.

Despite the fact that the participants had the benefit of free use of a local gym, uptake to the study was disappointingly limited. A wider geographical area and uptake, and therefore a larger group would be needed for statistical testing. Additionally, due to the small sample size, the use of a control group with CLBP (no intervention) was not feasible. Future research using a larger sample size would benefit from the inclusion of a control group.

Owing to the difficulty experienced with recruitment and the impact of this on completion of the study before hand in dates, the experiment was reduced from 8 to 6 weeks. This is significantly shorter than the 10 week period used by other researchers conducting studies into the effects of specific exercise (O'Sullivan, 2000).

Despite this, the 6 week programme used in this study is consistent with evidence that suggests that muscle hypertrophy becomes the predominant factor in increased strength after 3 to 5 weeks of training. Prior to this, increased strength is attributed to neuromuscular factors (Moritani & deVries, 1979). Additionally, the choice of 6 weeks duration of training could run in parallel with a typical schedule of osteopathic treatment for LBP.

The use of these study groups was labour intensive. Recruitment, pre- and post-assessment and exercise teaching was undertaken by co- researchers, reducing the overall impact of time constraints imposed by the undergraduate course. This could be a useful tool for future research projects.

During the course of recruitment, personal communication with prospective participants revealed some useful insights into the public's perceptions of exercise. One non-enlisted individual informed the researchers: 'I'm a general builder I don't need to use a gym; I get enough exercise at work'. This comment is actually very insightful and reflects the current trend in research in this area towards emphasising the need for exercise to be part of every day life rather than an adjunct (Dear & Underwood, 2005).

Finally, the 'Hawthorne effect' found in studies of this type, may produce different results than those produced in 'real' clinical settings due to behavioural changes in participants when being observed (Franke and Kaul, 1978).

Conclusions

The small sample size precludes any definite conclusions being made about the effect of general and specific exercise on lumbo-sacral stability. However, a visible trend was identified when considering median change, which suggested that specific exercise is more effective than general exercise at increasing lumbo-sacral stability. There is a need for more research into the effects of specific and general exercise on lumbo-sacral stability in the non-specific LBP population using a larger sample size, with a control group.

The limited scope of this study has also made it difficult to accurately draw any significant conclusions from the data obtained regarding the effect of exercise on subjective levels of pain in the participants. However, an obvious trend was identified suggesting that general exercise was more effective than specific exercise at decreasing subjective levels of pain. There is a need for more research into other modes of exercise (e.g. resistance exercise, spinal stabilisation exercise) to determine the optimum choice for the reduction of pain (Koltyn, 2002).

The diagnostic conundrum of LBP and the bio-psychosocial factors which account for an individual's perception of pain makes the appropriate prescription of exercise very difficult. This is compounded by the fact that exercise prescription/rehabilitation does not feature on some of the curricula of the major osteopathic schools in the UK (Dear et al., 2005). For osteopathy to progress into the 21st century, and remain competitive with other manual therapies, it is important to keep abreast of the current debate which ensues about appropriate exercise for the LBP population. Previous research has demonstrated that spinal stabilisation programmes are effective at increasing lumbo-sacral stability, although if the goal of clinical intervention is the reduction of pain, then general exercise is possibly a more obvious choice.

Waddell (1999) sums up the current research on the efficacy of different exercise interventions on LBP by claiming that the specific type of exercise is not important, it is the fact that the patient engages in some form of physical activity that determines the outcome.

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Original Research

The effect of whole body vibration training on patients with Ankylosing Spondylitis

Rudi Chaplin BSc (Hons) GSR

Member of British Association of Sports Rehabilitators and Trainers (BASRaT)

KEY WORDS

Ankylosing Spondylitis (AS)
Whole Body Vibration Training

ABSTRACT

Context: Ankylosing Spondylitis (AS) is a chronic inflammatory disease with symptoms including reduced spinal mobility and stiffness. Whole body vibration training is a recent advance in exercise and rehabilitation, with beneficial effects on both healthy individuals and those with selected disease. There has not, however, been a study into Whole Body Vibration Training (WBVT) on patients with AS.

Objective: It is the objective of the study to investigate the effect of Whole Body Vibration Training on outcome measures for Ankylosing Spondylitis.

Design: The study is a randomised control trial

Participants: 10 patients with AS were randomly assigned to 2 groups: The control group and The intervention group.

Setting: The control group continued exercise classes, and daily stretches. The intervention group undertook 15 minutes of WBVT 2 x weekly for 12 weeks.

Main Outcome Measures: The Bath Ankylosing Spondylitis Metrology Index (BASMI), Bath Ankylosing Spondylitis Functional Index (BASFI), The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and Bath Ankylosing Spondylitis Global Patient Score (BAS-G) were used.

Results: Bath Indices were used at week 1, week 6 and week 12 to measure aspects of AS. Scores at week 1 and 12 were significantly different in the intervention group for BASMI ($p < 0.05$), BASFI ($p < 0.05$) and BAS-G ($P < 0.01$). BASDAI scores for the intervention group were not significantly different for the intervention group but were significantly worse for the control group. BASMI, BASFI and BAS-G scores were not significantly different for the control group.

Conclusions: It is concluded that WBVT can significantly improve spinal mobility and sense of wellbeing in patients with AS. However, the sample size in the study is a limitation, and so further research is recommended

Ankylosing spondylitis is a chronic inflammatory disease for which there is no cure. It can be defined as "symptomatic sacroiliitis" with persistent pain of more than 3 months (Calin, 2006). Common symptoms include pain, stiffness and reduced spinal mobility (Dalyan et al, 1999). Inflammation of the entheses is also a symptom that develops into spinal ankylosis (McVeigh & Cairns, 2008).

The symptoms usually present in the late teens or early twenties (Calin, 2008). Males have a higher prevalence of ankylosing spondylitis than females (NASS, 2007). Diagnosis

involves investigations and review of patient history. Walker (2006) states that investigations include:

- 1) Slightly elevated C-Reactive Protein (CRP) and Erythrocyte Sedimentation Rate (ESR) levels
- 2) Negative results for immunoglobulin M rheumatoid factor
- 3) Presence of HLA-B27 (in 95% of patients). There is a strong link between HLA-B27 and Ankylosing Spondylitis.

McVeigh and Calin (2008) include other criteria for consideration in the diagnostic process:

- 1) Low back pain of at least 3 months that eases with exercise
- 2) Limited lumbar spine flexion and side flexion
- 3) Decreased chest expansion
- 4) Bilateral sacroiliitis grade 2, or unilateral grade 3

Radiological findings may not present initially, with changes to the sacroiliac joint only present in advanced cases (Walker, 2006). Limited mobility of the lumbar spine impacts daily living, and is closely associated with disability of Ankylosing Spondylitis (Dalyan et al, 1999). Treatment of Ankylosing Spondylitis traditionally consists of non-steroidal anti-inflammatory drugs (NSAID's) and physiotherapy (Braun & Sepier, 2007). In a literature review, beneficial effects were also noted in some cases with corticosteroids, disease modifying anti rheumatic drugs and biphosphates (McVeigh and Calin, 2008).

Multimodal exercise programmes have shown to have a significant difference on spinal mobility, work capacity and chest expansion when compared to medical treatment only (Ince et al, 2006). Group exercise has also been shown to be more effective than home based individual exercises in reducing impairment (Analay et al, 2002)

Measurements for ankylosing spondylitis

Various measurements are used to monitor symptoms of Ankylosing Spondylitis. The Bath Ankylosing Spondylitis Metrology Index (BASMI) consists of 5 measurements: Cervical rotation, Tragus to wall distance, lateral flexion, modified Schrober's and intermalleolar distance. These 5 outcome measurements provide an assessment of spinal mobility limitations. Jenkinson *et al* (1994) concluded that BASMI is easy to administer, reproducible and reflects change in mobility.

The Bath Ankylosing Spondylitis Functional Index (BASFI) is a questionnaire consisting of 10 questions relating to daily activities within the last month. The index has shown to be reliable, valid and effective in monitoring change (Spoorenberg *et al*, 1999). The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) is a questionnaire that rates the severity of symptoms experienced by the patient. The index has also been proven to be valid, reliable and sensitive to change (Garrett *et al*, 1994).

The Bath Ankylosing Spondylitis Global Patient Score (BAS-G) gives an indication of the patients perception of wellbeing over the previous week and the previous six months. The questionnaire has shown to be valid and reliable, and has a strong correlation with BASDAI and BASFI (Jones et al, 1996).

This correlation shows that disease activity and functional limitations will have an impact on a patient's sense of wellbeing.

Whole Body Vibration Training

Whole body vibration training (WBVT) is a relatively recent advance in health and fitness. A machine provides vibration of a plate upon which an individual will stand whilst performing various exercises.

Beneficial effects have been shown both acutely and chronically on neuromuscular function (Cardinale & Wakeling, 2005). It has also been shown to be as effective as resistance training in improving strength in untrained individuals (Delecluse, Roelants & Verschueren, 2003).

Cardinale and Wakeling (2005, p588) state that WBVT "may be an effective exercise intervention for reducing the results of the ageing process in musculoskeletal structures" Many research papers have been written regarding the effect of WBVT on a variety of diseases or conditions. Muscle spasticity reduced and strength improved in patients with cerebral palsy in a study by Ahlborg, Andersson and Julin (2006). Pain and fatigue in fibromyalgia patients were reduced following a six week programme of WBVT (Alentom-Geli et al, 2008). Mobility and Postural control was improved in patients with multiple sclerosis following WBVT (Schuhfried et al 2005).

One session of WBVT has been shown to increase voluntary muscle force and muscle activation of the quads in patients with stroke (Tihanyi et al, 2007). There are a few contraindications to WBVT, including acute thrombosis, cardiovascular disease, recent surgery, and pregnancy (Bodycoach, 2006). Ankylosing Spondylitis is not a specific contraindication to WBVT, though there has not been any research into its use for this condition. It is the purpose of this study to ascertain if there is a beneficial effect of WBVT on patients with Ankylosing Spondylitis.

Hypothesis

It is the hypothesis that whole body vibration will improve outcome measures of patients with Ankylosing Spondylitis.

Method

Design

A random controlled trial with a control group and intervention group

Participants

The study involved 10 patients, diagnosed with ankylosing spondylitis (55.8 yrs), all of whom attend weekly exercise sessions through NASS. All patients also have a daily routine of stretches that are conducted at home.

Procedures

The subjects were not undergoing physiotherapy treatment. The subjects were randomly assigned to one of two groups, using manual random selection of subject numbers concealed in an envelope by a third party. The control group simply continued with physical activity as normal. The intervention group continued a normal daily and weekly exercise programme, and in addition attended a gym with a Body-coach whole body vibration training machine (WBVT).

Blinding of the subjects was not possible, and blinding of the data collector did not take place. The intervention group attended the gym twice a week, and carried out a 15 minute routine, as prescribed by a sports rehabilitator. The first for each subject was in the presence of the sports rehabilitator. Demonstrations of the exercises were given, followed by an observation of the subject performing each. This ensured that the exercises were carried out correctly. The subjects were then given a sheet of exercises for future use, and qualified gym staff members were present for subsequent sessions.

The exercise programme for use on the Body coach machine was as follows:

- Standing calf raise (2 sets of ten repetitions)
- Squat (2 sets of 10 repetitions)
- Standing calf stretch (held for 15 seconds. Repeated 3 times on each leg)
- Standing Adductor stretch (held for 15 seconds. Repeated 3 times on each leg)
- Standing hamstring stretch (held for 15 seconds. Repeated 3 times on each leg)
- Single leg lunge (1 set of 10 repetitions on each leg)
- Standing side bend stretch- lateral flexion of the spine (2 sets of 5 repetitions each side)
- Seated thoracic rotations- with arms folded across the chest (2 sets of 5 repetitions each side)
- Standing full body stretch (held for 30 seconds, repeated twice)

Prior to the commencement of the 12 week study (start March 2009), all subjects completed the Bath Ankylosing Spondylitis Functional Index (BASFI), the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and the Bath

Ankylosing Spondylitis Global Patient Score (BAS-G) questionnaires.

A Sports Rehabilitator also took 5 measurements for the Bath Ankylosing Spondylitis Metrology Index. They were cervical rotation, Tragus to wall distance, lateral flexion, modified Schrober's and intermalleolar distance. This is the primary outcome of the study. The measurements were repeated at week 6 of the study (half way point).

One subject from the control group was excluded during the study due to hospital treatment of another, unrelated medical condition. All other subjects completed the study. At 12 weeks, BASFI, BASDAI and BAS-G questionnaires were repeated, as were BASMI measurements. The measurements were carried out by the same Sports Rehabilitator. The study was completed with 5 subjects in the intervention group, and 4 subjects in the control group. No adverse reactions or events were reported during the study.

Statistical Analyses

A t-test was used to analyse the outcome measurement results of the study for each group pre and post intervention. No other analyses was conducted

Results

The average age of the control group was 57.6 years, 3 males and 2 females and the average age of the intervention group was 54 years, 3 males and 2 females. BASMI scores at week 1 were not significantly different between the 2 groups ($p>0.05$). BASMI scores at week 12 were significantly different between the groups ($p=0.016$). BASMI scores at week 1 and week 12 were not significantly different for the control group ($p=>0.05$). BASMI scores at week 1 and week 12 were significantly different for the intervention group ($p=0.012$).

BASFI scores at week 1 and 12 for the control group were not significantly different ($P=>0.05$). There was a significant difference between weeks 1 and 6 for the control group ($p=0.02$). For the intervention group, the scores between weeks 1 and 12 showed a significant difference ($p=0.02$). There was also a significant difference between weeks 1 and 6 ($p=0.03$). BASDAI scores for both the control group and the intervention group did not show significant differences between weeks 1 and 6 ($p=>0.05$). The control groups scores were significantly higher (worse) from week 1 to 12 ($p=0.04$). The intervention scores were not significantly different between weeks 1 and 12 ($p=>0.05$).

BAS-G scores were not significantly different for the control group between weeks 1 and 6 and weeks 1 and 12 ($p=>0.05$).

The scores for the intervention group were highly significant between weeks 1 and 6 ($p=0.006$) and also between weeks 1 and 12 ($p=0.003$).

Discussion

The Bath Ankylosing Spondylitis Metrology Index (BASMI) was used as an outcome measurement in this study as it is conducted by a trained medical professional, and will give a measurement of spinal mobility (Jenkinson et al, 1994). It is effective in measuring change in spinal mobility. The use of these measurements ensured that the placebo effect did not possibly influence all outcome measurements. Limited spinal mobility, particularly flexion and side flexion is a symptom of ankylosing spondylitis, and therefore placebo effect will not influence the scores. In the control group, there was not a significant difference. In the intervention group, there was a significant difference at both weeks 1 to 6 ($p=0.025$) and weeks 1 to 12 ($p=0.012$). It appears that the use of whole body vibration training increases spinal mobility in AS patients in the short term (6 weeks), but also has a greater improvement over a longer time period (12 weeks).

The Bath Ankylosing Spondylitis Functional Index (BASFI) was used as it has shown to be reliable, and effective in monitoring change (Spoorenberg et al, 1999). A significant difference was shown in scores for the intervention group between weeks 1 and 6 ($p=0.03$), and a greater difference shown between weeks 1 and 12 ($p=0.02$). As the questionnaire is subjective, it is accepted that the placebo effect may have an effect on the scores. However, the BASFI is responsive to change. The BASMI scores are objective. As they showed a significant improvement, this will be likely to have an effect on the subjective questionnaires used in this study.

There was not a significant difference in scores for the control group between week 1 and 12, but there was a difference between week 1 and 6 ($p=0.025$). The exact cause of this short term improvement is unknown. In the opinion of the author, it may be a slight improvement due to a placebo effect. Being part of the study may have caused an increased sense of functionality in the control group. Having regular checks on progress of the disease may account for this. It is important to note, however, that this was the only score that improved for the control group.

The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) was used as it has been shown to be reliable and sensitive to change (Garrett et al, 1994). The effect of increased spinal mobility is thought to offer an explanation for improved scores, rather than a placebo effect. Scores for the intervention group were not significantly different between weeks 1 and 6 or weeks 1 and 12.

In the control group, scores were not different between weeks 1 and 6, but were significantly higher (worse) between weeks 1 and 12. These results suggest that whole body vibration training may prevent deterioration in BASDAI scores. This may support the results of Cardianle and Wakeling (2005), which shows ageing of musculoskeletal structures is reduced. The effects in patients with AS may reduce deterioration in condition.

The Bath Ankylosing Spondylitis Global Patient Score (BAS-G) was used as it is reliable and sensitive to change (Jones et al, 1996). It is subjective, but is a good measurement of a patient's sense of wellbeing. Scores were significantly different both at week 6 ($p=0.003$) and week 12 ($p=0.006$). These scores are significant when paired with improved BASMI scores. An increased spinal mobility will increase a patient's sense of wellbeing.

The limitation to this study is the sample size. Originally 10, and then falling to 9. This is a small sample size. However, the results are encouraging, and will warrant further investigation with a larger sample.

Conclusion

The results of this study show that Whole Body Vibration Training has a significant improvement in spinal mobility and sense of wellbeing on patients with Ankylosing Spondylitis. BASMI and BAS-G scores were significantly improved in the control group. A cautious and structured approach to whole body vibration training can have a beneficial effect on patients with Ankylosing Spondylitis. Due to the small sample size of this study, further study is recommended.

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Original Research

A retrospective study of sports injury during football matches over two seasons. Does fatigue affect injuries?

Lucia Abbate BSc (Hons) ST

8 Douglas, Little Strand, Colindale, London NW9 5NS

KEY WORDS

Fatigue
Injuries
Football
Soccer
Matches
Seasons

ABSTRACT

Objective: Review all injuries that occur with players in football matches in season A and season B. Focus whether fatigue has an effect on injury rates during matches and what are the most common injuries.

Methods: Injuries were assessed by the data being collected from injury log book of football players of Nuneaton Town FC during competitive matches over the season A (28 injuries), and reviewed, compared and combined from competitive matches to the subsequent season B (23 injuries) so overall 51 injuries.

Results: Common injuries were hamstrings (27%), ankle (18%) and knee (14%). There was no significant difference in injuries between seasons, most injuries occurred in last 15 minutes of each half, there was significantly more injuries in second half than first half ($P < 0.05$). Beginning of the season there were more (33%) injuries compared to mid season (27%) and varied at end of season (39%). Most injuries were Minor to Moderate injuries; 46% moderate in season A and 48% major in season B.

Conclusion: Fatigue could have possibly had an effect on injuries rates. Studies have shown technical skills decrease towards end of first and second half probably as a consequence of physical fatigue, with decrease in performance can cause players to be careless in the match resulting in injury to them selves or another player. Since more injuries are likely to be minor or moderate injuries, this again could be link to fatigue as with minor injuries could again be due technical skill, as more major injuries could be due to chronic injuries due to overuse or very high force. Fitness training can help players maintain technical skills and endure physical demands of football.

Football (soccer) is one of the most popular sports worldwide with over 256 million players in year 2006 (Yard *et al* 2008). Looking at football injuries, the players are known to suffer from fairly high rates of injury compared with other participants in other sports and other occupations (Hawkins and Fuller 1999). Injuries in football matches are three times more frequent than in training (Reilly 1996); this study is investigating injuries during matches.

Most football studies use the 'time loss' definition of injury, meaning recordable injury is one that has caused absence from participating in football (Hagglund *et al* 2005). With fatigue is defined as a decline in performance due to the need to keep on performing (Reilly 1997). It's an important legal requirement for managers of professional football clubs to reduce this level of risk in any way they can to ensure

health and safety of their players (Hawkins and Fuller 1999). Studies like this can help identify and prevent injuries.

The cost of injuries to soccer players is vast, not only will it affect overall team results, the cost of treatment and loss of production has been estimated in professional level to be about £1 billion in Britain each year (Rahnama *et al* 2002). More participants in football this means more injuries occurring. For that reason in football efforts must be made to prevent and control injuries, by altering factors that can reduce risk (Hawkins *et al* 2000).

Aims, objectives and hypothesis

Aim: Analysing the types of injuries occurring over football matches within two seasons and what time in the game the injury occurred to see if fatigue affects injury.

Objective: Review all injuries that occur with football players in season A and B, during football matches. Focusing whether fatigue has an affect on injury rates during matches and what the most common injuries are. This is done by seeing what times these injuries occur in matches for example if happened in first or second half and to see if occurred in last quarter of the game, with what type of injury it is.

Hypothesis: There will be a relationship between injury rates and fatigue, with few injuries being major severity and most common injuries mainly occurring in lower extremities.

Materials and methods

Design

The way the information gained from the log book by going to Nuneaton Town FC. This is an injury log book made by the physiotherapist, for personal records to keep track of injuries. The information collected anonymously, with the subjects given a code number; the data was not directly copied from injury log book (e.g. photocopied). Therefore only the relevant data was placed into excel. An ethics exemption form was given due to no identifiable data being used in this study, no medical forms were looked at. There was nothing recorded to easily identify the players in the club, such as height, weight, position and their name and address would not be used as not needed. Since this information was not relevant it was excluded.

Other exclusion criteria were players who played under 30 football matches, as the club have on average 60 matches per season, and using data lower than 30 matches will cause an effect on the results when looking at fatigue and injury. The inclusion criteria was certain (relevant) information used from the injury log book, therefore only the severity of injury, what type (e.g. injury on Quadriceps), what time in the match and season (month) the injury occurred was used.

Participants

Injuries were assessed by the data being collected from football players of Nuneaton Town FC ages 18-35 years old from the injuries reported in the log book during competitive matches over the season August to April 2006-2007 (Season A) with 28 injuries, reviewed, compared and combined to subsequent season August to April 2007-2008 (Season B) with 23 injured players, overall 51 injuries.

Procedures

An injury in this study was defined as footballers who have reported to the physiotherapist within 48 hours of the match the injury occurred in, under the Reporting of Injuries, Disease and Dangerous Occurrences Regulations (RIDDOR)

(Price *et al* 2004). When defining the severity of the injury, it was measured by how many days the footballer was not able to participate in the sport 1-7 days minor, 8 days to 4 weeks moderate and over 28 days as major, this was chosen by looking at several studies example is Hawkins *et al* (2001) and using these categories severity of injury according to UEFA consensus discussions (Hagglund *et al* 2005).

Statistical analysis

The statistical test used for this study was X2 (Chi squared) to investigate differences between injuries, severity of injury and the time in the match and season injury occurred. Significant was accepted by $P < 0.05$ with results more significant $P < 0.01$, with some values expressed as means. Studies such as Hawkins *et al* (2001), Woods *et al* (2004) and Walden *et al* (2005), among others have shown to use these statistical analyses while doing similar studies to this one.

Results

The results were rounded to nearest whole or a 0.5 percentage, with the statistical test being rounded to 2 decimal points and mean for severity of injuries. Injuries were analysed by seasons (Season A and Season B) and all 51 injuries (overall).

Review of injuries

Table 1: percentage of the injuries occurred

INJURY	SEASON A 2006-2007 (%)	SEASON B 2007-2008 (%)	COMBINED OF BOTH SEASONS (%)
Shoulder	3.5	0	2
Back	14	9	12
Hamstrings	28.5	26	27
Quadriceps	3.5	13	8
Groin	3.5	9	6
Gastroc/ Soleus	3.5	9	6
Hernia/ Abdominals	3.5	4	4
Knee	14	13	14
Ankle	18	17	18
Lower leg/ Foot	3.5	0	2
Hand	3.5	0	2

In season A (75%) with season B (87%), (overall 80%) were in the lower extremities. 32% Season A and as high as 39% season B (overall 35%) were thigh injuries, with overall injuries 20% of all lower extremity were ankle injuries.

Table 1, 51 injuries: shows hamstrings highest injury with 27%, 18% ankle injuries all lateral aspects, while 14% were knee joint injuries mainly medial collateral joint (MCL).

Chi squared (X^2) results using Critical value is 3.84, and showed that there were no significant differences between any of injuries between the season, fairly similar percentages ($P > 0.05$), there was however a significant difference between the amount of anterior thigh injuries to posterior thigh injuries, that the hamstrings were significantly the more common injury in football in this study, season A 28.5% v 3.5% ($P < 0.01$) and season B 26% v 13% ($P < 0.05$), with overall results of injury data being at 54.5% more posterior thigh injuries and significant difference shown ($P < 0.01$).

Severity of injuries

Table 2: percentages and means of severity of injuries occurred in the match

SEVERITY	SEASON A 2006-2007 (%)	SEASON B 2007-2008 (%)	COMBINED OF BOTH SEASONS (%)
MINOR	36	48	41
MODERATE	46	43	45
MAJOR	18	9	14
MEAN	38 days	12 days	25 days

When looking at table 2 in all 51 injuries 86% injuries are minor to moderate injuries, there are more moderate injuries in season A (46%) with more minor injuries in season B (48%). The mean value of amount of days out of play in a season was 38 days (major) for season A and 12 days (moderate) for season B. There was a significant difference between season A and season B severities ($P < 0.01$). Season A was high due to anomaly, if was removed would show no significant difference between seasons.

Fatigue and injury

Figure 1 shows as the game goes on the injuries increase until reaching half time, the injuries decrease before increasing again. Also most injuries occur in the last 15 minutes of each half, first half (21 %) and second half (28.5%). There are more injuries in the second half with overall 10 injuries in first half (36%) and 18 injuries in second half (64%).

Figure 2 shows similar results to season A, apart from there is no injuries in the first 15 minutes, then last 15 minutes of the first half increase to 30 %, then drops in the beginning of the second half to 9 % before increasing in last 15 minutes to 35 %, again more injuries in second half than second half (57% v 43%).

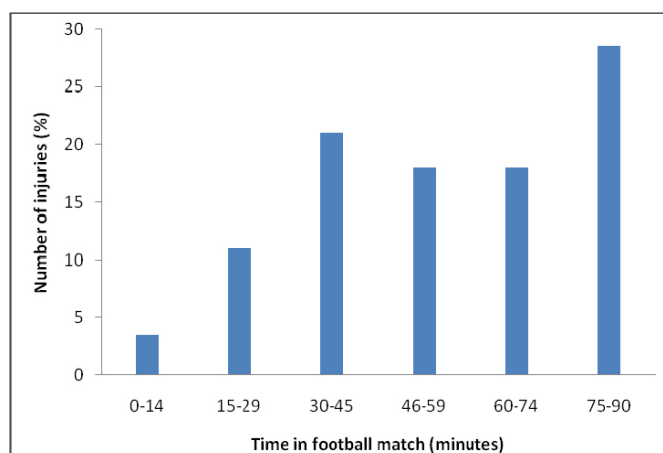


Figure 1: Season A, the time injury sustained during match play

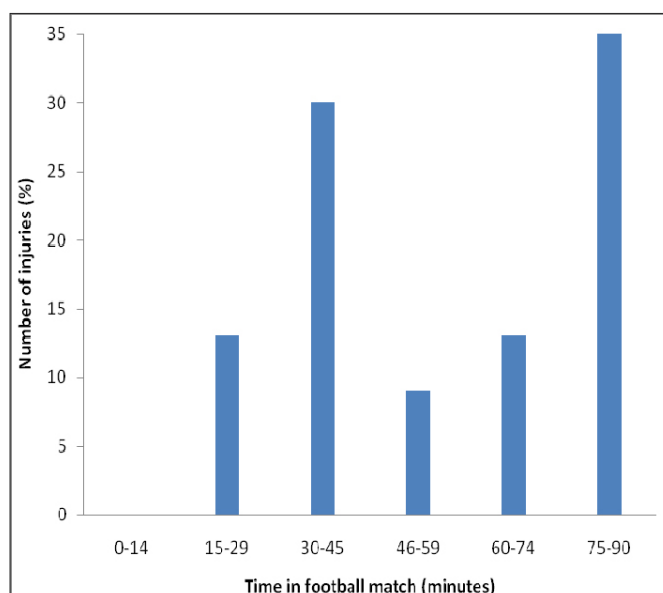


Figure 2: Season B the time injury sustained during match play

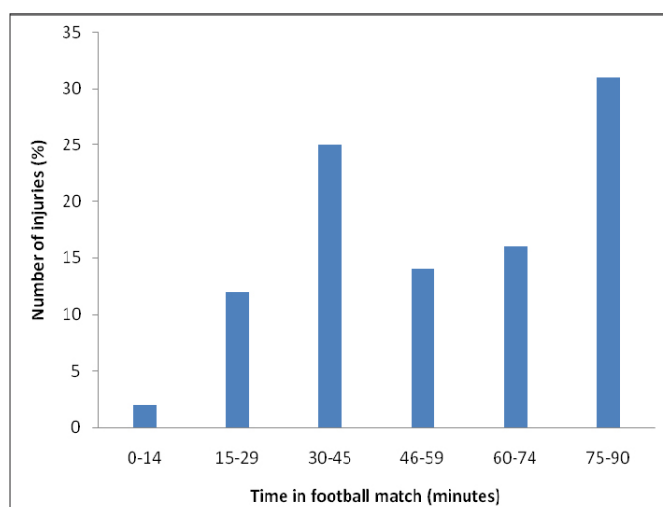


Figure 3: All data from both seasons looking at the time injury sustained during match play

When looking at figure 3 it shows overall injuries (51 players) injuries and what time in the match the injury occurred. Showing biggest injury rates occur in last 15 minutes of both halves, but larger in last 15 minutes of the match (31 %) than injuries in second half (25%). Looking at all 51 injuries in both seasons; more injuries occur in second half than the first half (61% v 39 %).

Time in the match the injury occurred showed significant difference ($P < 0.05$) that there were more injuries in second half then first. There is also a significant difference between injuries in last 15mins of each half to have most amount of injuries ($P < 0.01$), however no significant differences between seasons ($P > 0.05$).

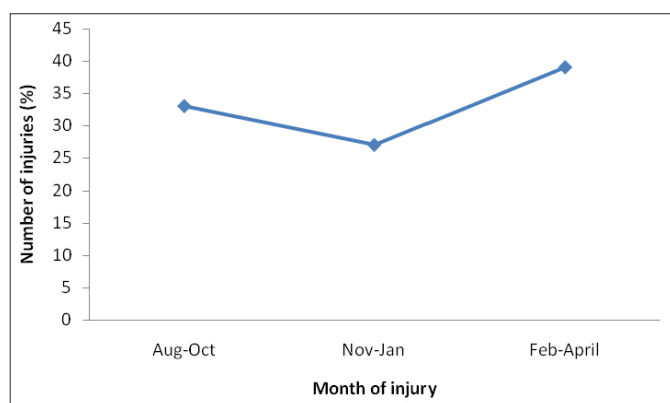


Figure 4: all data from both seasons looking at the time in the season the injury occurred during a match

Time in the Season

Figure 4 results are spilt into every three months. When looking at figure 4 it shows that at the beginning of the season there are quite a few injuries (33%), and drops in mid season (27%) before most injuries occur at the end section of the season with 39% (20 injuries). There were not a lot of subjects to determine if the time in season had affect on injury rate, but when looking at the results in season A only had two injuries while season B had one injury in December where the mid season break is, while in April, (the end of the season) having one of the most injuries in both seasons. There was no significant differences between seasons ($P > 0.05$).

Discussion

The impact of injuries on a club can be determined in relation to its severity and the number of potential competitive matches missed (Woods *et al* 2003); the study concentrated

on match injury as the majority of injuries occur in football games than during practices (Caine *et al* 1996). The results shown in this study supports the hypothesis as proved below. There were no significant differences between seasons, similar attributes occurred.

Review of injuries

Lower extremity injuries are usually the most common in football, and this study shows overall 80% were in the lower extremities. As the lower part body is mainly used, injuries usually occur from tackling as players cannot respond quickly to avoid an unpredictable rapid movement (Wong and Hong 2005).

The most prominent injuries were located on thigh, ankle and then knee. This study shows overall 35% were thigh injuries, the reason that the upper leg is most common part to be injured possibly due to the large muscle mass on upper leg and therefore the large area exposed (Wong and Hong 2005). Hamstring strains commonly reported in football, result from a quick forceful stretch of the muscle, in attempt to change direction, accelerate, decelerate or stretch for the ball (Reilly 1996).

There was significant differences between posterior thigh and anterior thigh injuries, with overall 54% being more posterior thigh (hamstrings) injuries ($P < 0.01$). Highest study showed (67 v 36) injuries were posterior thigh strains than anterior (Walden *et al* 2004). High injuries to hamstrings possibly due to the group functions over two joints so therefore more likely to stretch at more than one point, also have a greater proportion of fast twitch fibres therefore more capable of high force production (Woods *et al* 2004).

(Ekstrand and Gillquist 1983 and Hawkins and fuller 1999) shows relationship between muscle strains due to muscle tightness. Beneficial effects are shown by warm ups and cool downs and strength and flexibility training to reduce muscle tightness.

Ankle and knee injuries are most common joint injuries when looking at football. Looking at table 1, analysing all lower extremity injuries 20% of injuries consisted of ankle injuries overall 51 injuries 18% ankle injuries all being lateral aspects. With other studies such as Reilly *et al* (1993) suggest 30% of lower extremity injuries are ankle injuries and 75% involves the lateral ligaments.

When looking at football a possibility for vulnerability of ankle joint is its close proximity to the ball, consequently high

chance of injuring the ankle when shooting, tackling and dribbling (Wong and Hong 2005), also due common movements in football as well as contact with players (Woods *et al* 2004).

Lateral ankle sprains account for the majority of ankle injuries this usually happen as a result of landing on an inverted plantar flexed foot, (which also position of foot when striking the ball) (Reilly 1996) with the anterior talofibular ligament (ATFL) being the weakest ligament and most commonly injured (Puffer 2001).

Knee joints are vulnerable to injury when subjected to sudden external force, when leg is planted in the ground by football boots, therefore unable to rotate inwards when subjected to a flexion force (Reilly 1992). Hawkins *et al* (2001) suggest as it's the centre lever arm of the leg therefore more vulnerable to greater forces being transmitted from the hip and trunk as well as from the ground through the foot and ankle. The main knee injury in this study was MCL. Damage to the MCL is approximately 5-10 times more common than LCL (Ekstrand *et al* 2003).

When looking at the results from study there were no significant differences between the main injuries (hamstrings, ankle and knee), this is due to them being most common, so expected high percentage for these areas for both seasons.

Severity of injury

Highest study Rahnama *et al* (2002) shows over 65% being minor injuries. Table 2 in study shows season A 46% moderate injuries and season B 48% minor injuries. The mean average of days out of play shows a significant difference between seasons ($P < 0.01$). The reason to the high mean average in season A was due to an anomaly. An injury of back disectomy encountered a subject to be out of play for 544 days which brought the mean up. However when removing this injury, the mean results being in 17 days (moderate), which shows no significant difference between seasons ($P > 0.05$). Similar results from Hawkins *et al* (2000) 68% were moderate or minor injuries, this could be link to fatigue as with minor and moderate injuries could be due technical skill, as more major injuries could be due to chronic injuries due to overuse or very high force collisions with players.

Fatigue and injury

Muscle fatigue is identified as a factor of physical demands in football as cause of injury (Hawkins and Fuller 1999) and

could be the main reason for the greater injuries occurring in the last 15 minutes and looking at figure 1, 2 and 3. Was significant difference overall of more injuries occurring in second half than first (61% v 39 %); ($P < 0.05$). As fatigue develops the amount of technical and physical performance is decreased (Rampinini 2007), this usually happens after a period with a large amount of high-intensity exercise Mohr *et al* (2002). Where these fatigue bouts occur, possibly be where injuries occur as there technical performance is lacking which could cause mistakes such as poor judgement for tackle, kicking or changing direction wrong, therefore causing injury to themselves or another player.

Aerobically well trained players are more able to maintain their work rates towards the end of the match (Reilly 1997), so suggests theoretically would show a reduce risk of injury due to fatigue. When footballers become fatigued during sprinting, early activations muscles occur, due to local muscle fatigue and/or neural (central brain) fatigue resulting in injury (Hawkins *et al* 2001), this can be due to repeated dynamic efforts occur when playing football, for example, sprints and kicking, which will more likely cause fatigue (Pinniger *et al* 2000).

Players should focus on improving their ability to recover quickly from periods of high-intensity exercise and to perform intense exercise to prevent fatigue (Mohr *et al* 2002). Fitness training can help players maintain or improve the technical abilities and physical performance throughout a match and endure the physical demands of football. Every footballer regardless of standard of play can benefit from fitness training programme between matches (Bangsbo 1994). As this will reduce fatigue, thus possible reduction in injuries during matches.

Time in the season

When looking at the time in the season the players were injured (Figure 4), no significant difference between seasons ($P > 0.05$) as seasons have similar patterns looking at time injuries occur. Nevertheless when analysing overall there were more injuries after preseason (beginning of season) and end of season. However previous studies have not accounted for variation on intensity of competition matches over a season, this was shown in several studies by graphs. Could be due to loss of fitness during the close seasons and this has a potential impact on player's performance (Hawkins and Fuller 1999).

Players may not reached appropriate levels of fitness during or in closed season causing players less capable to withstand

the stress of early season competition, which leads to higher possibility of injury (Hawkins and Fuller 1999). The have or training may be inappropriate or too intense to allow adaptation to occur (Price *et al* 2004). Therefore deliberation should be given on the level of closed season, mid season break and content of preseason training, with physiological testing of players used to make judgement of their fitness (Hawkins and Fuller 1999).

This will maintain and increase fitness before season as there are no matches before season to prepare body and maintain fitness at end of season to decrease fatigue which may possibly decrease injury rates (Bangsbo 1994).

Conclusion

As most injuries occur more during football match than training, this study has focused on match injuries, most injuries are in the lower extremities as the lower part of the body is used most in football, for example running, tackling and kicking the ball. Hamstrings were most common injury, which possibly due to muscle tightness and hamstrings are a common muscle to be tight due to the nature of the movements during football matches. Benefits to reduce risk of injury are warm ups, cool downs and strength and flexibility training to reduce tightness of muscles.

Fatigue could have possibly had an effect on injuries rates, as most were shown in the last 15 minutes of each half of the match, with more injuries in the second half. Studies have shown technical skills decrease towards end of first and second half probably as a consequence of physical fatigue, with decrease in performance can cause players to be careless in the match resulting in injury to themselves or another player due to bad technique as muscles are not activating quick enough or working to their strengths to either move in time, change direction that body's prepared for or good timing on a tackle. Since more injuries are likely to be minor or moderate injuries, this again could be link to fatigue as with minor injuries could again be due technical skill, as more major injuries could be due to chronic injuries due to overuse or very high force. Fitness training can help players maintain technical skills and endure physical demands of football

There were more injuries after preseason (beginning of season) and end of season and less injuries in mid season break. By concentrating on fitness programmes and fitness testing during pre season and mid season break, will maintain fitness before season (as there are no matches before season) and end of season to decrease fatigue which may decrease injury rates.

Limitations

More data is needed (for example adding another season), for clearer results in this study. Although there are significant differences shown to show higher significant differences and to improve on results for time in the season player was injured as these results were not very clear and 51 injuries will not be able to show justified results for this area.

More data will show the means and severity of injury clearer, as there was an anomaly due to back disectomy injury causing a subject to be out of play for 544 days, so more data would have balanced out the mean average giving a more reliable result.

Also rather than taking seasons from the same football club, comparing two different clubs in the same season and to improve this greater they should be at different levels, for example semi professional club and a professional club. Thus to show more clearly if fatigue does have affect on injury rate, and if it is more prominent in professional football team which are careers for the footballers

Acknowledgements

Greatly acknowledge support of Nuneaton Town Football Club involved in this study, players, managerial and coaching staff. Expressed gratitude for the help and commitment from physiotherapist Paul Egan and to lecturer Philip Smith is also greatly appreciated.

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Reviews and invited commentary

Research concepts and methods – 2 Quantitative data inputs with quantitative responses

David Jenkins MSc, MA.

Department of Postgraduate Research
University College Birmingham, Birmingham, UK

KEY WORDS

Research philosophy
Research paradigms
Research methods

INTRODUCTION

In the previous edition of the *Journal of Sports Therapy* I introduced this series with an outline of the relationship between the epistemological level of research philosophy, or the source and sourcing of knowledge, and the need to carefully consider the overlapping nature of subjectivity and objectivity. It was argued that even the most positivistic and objective of researchers not only depend to some extent on their own, 'first-person' interpretation of the results of their empirical and statistical investigations, but also must demonstrate some elements of subjective, *qualifying* judgment in the choice of procedure, or test, to employ in the first place. Similarly, those sports therapy enquirers operating at the interpretivist end of the epistemological spectrum would find it very difficult to organise the qualitative data gleaned from their research into meaningful information without the use of some form of quantification or measurement. That is, in order to identify themes, patterns, and trends in words and images, there is the attendant need to categorise, or group, these data in order to make any sense of them, and that means, even at the most basic level, counting or *quantifying* them in some way.

We can then summarise this by saying that at the epistemological level there are inherent interdependencies between detached and objective, sensory, third-person measurement; and subjective, first-person, involvement and interpretation. This, in turn, can be seen to offer certain levels of liberation for social science investigators in general, and sports therapy researchers in particular, because it suggests that the positivist researcher need not be confined to, or restrained by, only quantitative methods and analysis, or that the interpretivist should intuitively disallow the employment of numbers in assisting with the translation of qualitative data into meaningful outputs. Moreover, with a little imagination and a few assumptions we can extend this line of reasoning to promote the notion of a four-way, matrix-type construct of the complementarity of research methods.

By starting with the generally-accepted view that raw or organised quantitative data inputs, are usually (or optimally) translated into response variables or outputs for analysis using statistical modelling and other forms of quantitative methods, and that similarly, raw or organised qualitative inputs are translated into analytical outputs using interpretive modelling and other forms of qualitative methods, we have the first two elements of the proposed matrix. These can be considered as the quantitative-quantitative, and qualitative-qualitative method constructs, and can readily be used in tandem. For example, it is common for researchers to triangulate, say, by conducting a questionnaire survey in order to

elicit numerical input variables, then employing some form of statistical method to generate response variables to make sense of the data, and to follow this analysis up by interviewing a number of subjects, the outcomes of which would be interpreted so as to either align with and support, or maybe contrast and challenge, the findings and conclusions gleaned from the quantitative modelling and analysis. In much the same way, a quantitative, questionnaire survey may be used to triangulate a data set generated by a series of interviews, focus groups, or observations.

While this is all very useful, and is often, although in some cases rather loosely, described as mixed-methods research, it clearly separates the methods, only bringing them together in contingent and convenient circumstances, a little like saying 'Let's see what they have to say on the other side'; and by considering this as a 'between methods' relationship it largely overlooks the possibilities of the relationships that lie 'within methods'. However, an examination of the relationship within methods pays dividends, because this reveals that not only can we generate quantitative response variables from qualitative data inputs in the same way that the Chi square (χ^2) statistical technique yields a number that quantitatively measures the levels of agreement or disagreement of respondents' qualitative opinions; but it is also possible to produce qualitative response variables from quantitative data inputs, as in binary and logistic regression, log-linear, and ordinal logit modelling.

This then allows a four-way matrix comprising relationships between data input variables and response (output) variables in the following paired, in-out configurations; quantitative-quantitative, qualitative-qualitative, qualitative-quantitative, and quantitative-qualitative. Table 1 below summarises this matrix

Table 1. A four-way research methods matrix

	Qualitative (output) responses	Quantitative (output) responses
Qualitative input variables	Raw data collected from interviews, group interviews, focus groups, and observations, organised into information and summarised and reported upon using words, images, meanings, and descriptive statistics.	Raw data from interviews, group interviews, focus groups, and observations, organised into information and summarised and reported upon using methods based in nominal and ordinal numbers.
Quantitative input variables	Raw data collected from populations and samples via surveys, questionnaires, data sets, and empirical experiments etc., and summarised and reported upon using words, images, meanings, and descriptive statistics.	Raw data collected from populations and samples via surveys, questionnaires, data sets, and empirical experiments etc., organised into information and summarised and reported upon using methods based in discrete and continuous data.

Source: primary

The four relationships described above, and illustrated in the accompanying matrix table form the basis of the next four discussions in this six-part series regarding research concepts and methods. The following section, and remainder of this article, considers the relationship between quantitative data inputs and quantitative response variables, or analytical outputs. It is not intended as yet another set of didactic or prescriptive illustrations of 'how to do statistics', nor does it offer guidelines as to which specific quantitative model is best suited to individual research scenarios (for detailed guidance in these areas see¹ below), but rather strives to outline the conceptual underpinnings of each of the groupings, or typologies, of methods involved in the quantitative input-quantitative output relationship. In this way it is anticipated that the reader will be better informed in terms of the options available when considering the choice and construction elements of research design, the sampling framework, and

planning data analysis. As a departure point for this, the next section considers some of the preliminary questions that the quantitative researcher must answer before moving towards the physical collection of data – regardless of whether these data are to be generated from primary or secondary sources.

From raw data to information, and from information to analysis.

One of the traps that many new researchers fall into when enthusiastically embarking upon primary research through the use of questionnaires is that they design, and often distribute, the questionnaire before they do anything else. And, while such enthusiasm is understandable, it is a little like writing a letter before you decide who to send it to! A simple approach is to consider the *order* of operations involved in the research process. In much the same way as arithmetic and mathematics requires us to adopt the 'exbodmas' order – that of exponential (powers of numbers) calculations first, then by brackets opened (by conducting the calculations inside parentheses), followed division, multiplication, addition, and subtraction last safeguards us, for example, from arriving at 18 through computing $6+3 \times 4 \div 2$, when 12 is the correct answer².

In order to offer a similar set of ordered operations to aid the quantitative research process, we can first consider the overall sequence of events as below'

Questions > Answers > Raw data > Information >
> Testing > Analysis > Findings > Conclusions.

A cursory examination of this at first suggests a straightforward, left-to-right process: simply ask the questions, obtain the answers, collate the raw data into information, conduct the test(s), do the analysis, arrive at some findings, and draw conclusions. However, although this describes the stages of the actual, or empirical, quantitative research process, it is of little help. This is because there are a number of contingent relationships linking these individual components. For example, take any point along the above continuum, say the conclusions stage. You decide that you are aiming to establish if, as suspected, two sets of variables, 'x' and 'y', are related to each other in such a way that the behaviour of one of the variables, say y, may be affected by the other, x; and, if so, can x be seen to *cause* y to occur; and if it can, is it possible to predict future values of y from selected values of x? What would you need, and where should you start? By working *backwards*, or right-to-left along the line, you would be forced to answer the question 'how can the findings be most suitably framed in order to lead to these types of conclusions? From

¹See, for example, Agresti and Finlay (1997); Cramer, (1997); Friend, (1987); Moore, (2000); Rowntree, (1991); and Swift and Piff, 2005)

²Calculating this *left to right* would yield eighteen, because six plus three equals nine, nine multiplied by four is thirty-six, and thirty-six divided by two determines an answer of eighteen! The correct order of operations here is to divide the four by two to give two, multiply the two by the three to arrive at six, and then add the two sixes together to give twelve.

this, how might the analysis be designed to generate the framework for the findings to inform the conclusions in this way? Next, which tests and associated results are available to be able to feed into the type of analysis required? And then, what information is deemed necessary to input into such testing, what sort of raw data are, or can be made available, in order to shape this information, what type answers are likely to provide these data, and finally, how can the questions that generate the answers required be best couched, and in what order should they be asked?

Establishing an order of operation

Just as the arithmetic example above requires a particular order for the mathematical operators to be consistently and unequivocally employed, a similar logic can be introduced to the quantitative research process. This can be seen as a pair of interlinked linear sequences derived from the single continuum illustrated above, and that can be identified through a secondary series of questions, as outlined in table 2 below.

Table 2. Research design and process considerations

Secondary questions	Alternative answers
What type of analysis is required?	Exploratory, explanatory, descriptive, or predictive.
What forms should the (raw) data inputs take?	Discrete numbers (whole numbers, sometimes called integers) or continuous numbers (infinite numbers).
Which scale do these data need to be ordered into in order to compile the appropriate information?	Ordinal scales (ranked or ordered), interval scales (equally distanced, usually proportional, sometimes comparative, but not always relational), or ratio scales (proportional, comparative, and always relational)
What forms of outputs are required?	Hypothesis-based, illustrative, comparative, relational, generalisable, inferential, associative, or predictive.

Source: primary

Returning to the example above of 'x' and 'y', and applying the secondary questions in table two, we would derive the following. The type of analysis required would be predictive using bivariate regression techniques³. Raw data inputs here could be either discrete or continuous. The information will be required in either interval or ratio, but not ordinal scales. And, the outputs would be relational for the correlation part of the

regression construction; and predictive, in that future values of y may forecasted from given values of x.

It can now be seen that the process may be separated into two broad spheres of activity: those of data collection and data analysis. That is the collection of *raw* data and the subsequent analysis of informational or *refined* data. With this in mind, the original continuum of the sequence of events illustrated above can now be redrawn to represent a simplified view of the quantitative research process, as shown below.

Raw data > Refined data > Output data

Moreover, this now suggests that the various levels of research design questions that the researcher must ask are all underpinned by data considerations, and can, perhaps, even be inverted or re-ordered to ask firstly 'How, and in what form, do I want to end up showing the results of my research, what information is needed for the analysis to do this, and therefore what data is needed for such information?' This then offers a basic conceptual framework for the researcher to consider the process, by effectively placing data typologies at the centre of research design, and also reversing the order of questions to look like this

Output data required > Refined data required
> Raw data required

By returning to the letter analogy above where I suggested designing a questionnaire, or effectively attempting to collect data, before considering anything else is like writing a letter before deciding who to send it to. This could be extended to argue that if you haven't decided *who* to send it to, you won't know *what* to include or *how* to write it. That is, the ultimate contents of the letter, or its output data, will determine who should, or would, benefit from receiving it. Moreover, if the intended recipient has already been identified, you will need to establish both the level and type of output data that conveys your message most appropriately and effectively.

Towards sampling determination and understanding the behaviour of data variables

For the sports therapy researcher planning to engage in research requiring quantitative inputs and quantitative outputs then, it is clear that the identification of intended output data will determine what raw data inputs are needed, and therefore due consideration to types, levels, and quantities of data are central to the whole process. However, what has yet to be addressed here are issues concerning data sample size, the associated distributions and limitations of these data, and the relationship between data

³For comprehensive coverage of both bivariate and multivariate regression techniques and analyses see Swift and Piff (2005), and Agresti and Finlay (1997)

samples and known and unknown populations. These concerns will form the basis of the next article in the series, and in doing so will attempt to search for a response to one of the major problems confronting quantitative research in general, and the collection of sample data in particular, that of the *paradox* of sampling, and which is nicely described by Derek Rowntree

The problem has been called the 'paradox of sampling'. A sample is misleading unless it is representative of the population; but how can we tell it is representative unless we *already* know what we need to know about the population, and therefore have no need of samples! (Rowntree, 1991:23) (*Italic emphasis added*)

It is perhaps disconcerting that this paradox can never be completely resolved, and this of course means there will always be elements of uncertainty in quantitative methods – although can we ever be 100 percent certain of anything anyway? However, appropriate selection of quantitative methods and statistical methodologies enable us to collect samples that are likely to be as representative as possible. By considering the issues raised here regarding the importance and centrality of raw data collection and its refinement into information, and by the exercising of appropriate statistical rigour and caution, the generation and sensible reporting of quantitative outputs can be amongst the most powerful tools the sports therapy researcher has available.

The next article examines the various categories and families of data variables, explores their behaviour, and shows how a basic understanding of this behaviour may assist us in the selection and deployment of the most appropriate data samples for quantitative research.

David Jenkins

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Example:

Since Paterson (1983) has shown that ... This is in results attained later (Kramer, 1984: 16). Results have been reported (Robinson, 1989, personal communication) which suggest

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Paper in journal

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Blinder, A.S. and Solow, R.M. (1970) 'Analytical foundations of fiscal policy', *Journal of Finance* XXV: 47-54.

Bender, J., Bloggs, B. and Swistak, P. (1997) 'The evolutionary stability in cooperation', *American Political Science Review* 91(3): 290-297.

Book

Giddens, A. (1990) *The Consequences of Modernity*, Cambridge: Polity.

Kay, J., Mayer, C. and Thompson, D. (1986) *Privatization and Regulation*, Oxford: Clarendon Press, pp. 105-129.

Brown, C. (ed.) (1994) *Political restructuring in Europe: Ethical Perspectives*, London: Routledge.

Chapter in book

Hook, G.D. (1998) 'Japanese Business in Triadic Globalization', in H. Hasegawa and G.D. Hook (eds.) *Japanese Business Management: Restructuring for Low Growth and Globalization*, London: Routledge, pp. 19-38.

Conference paper

Altenstetter, C. (2001) 'Multi-level implementation networks: The case of medical devices and patient care'; Seventh Biennial Conference of the European Community Studies Association (US), Madison, Wisconsin, 31 May-2 June.

Thesis

Zito, A. (1994) 'Epistemic communities in European policy-making' Ph.D. dissertation, Department of Political Science, University of Pittsburgh.

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