RELATIONSHIPS OF SUBJECTIVE PAIN AND SORENESS RELATIVE TO PRIMARY VOLUME LOAD AND SPECIFIC TRAINING CYCLES

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INTRODUCTION: Monitoring has been defined as a spectrum of activities leading to an understanding of the training and performance process (Stone, Stone, & Sands, 2007). Questionnaires can be used to assess a variety of qualities such as an athlete's internal training load, perceived stress, and delayed onset muscle soreness (Borreson & Lambert, 2009; Halson, 2014; Storey et al., 2016). Subjective measures such as questionnaires may be sensitive to training load, and therefore show promise as non-invasive, practical, and affordable monitoring tools (Saw, Main, & Gastin, 2015). Questionnaires may also be used to evaluate perceived levels of soreness and pain encountered in training. These are qualities that may be of use to coaches and sport medicine providers. The questionnaire used in this study was adapted from Stone, Stone, and Sands (2007), and further developed to serve as a screening tool used to direct athletes to sport medicine services.

Several methods of receiving pain and soreness data are available. The Numeric Pain Rating Scale (NPRS) has shown to be superior over other reporting mechanisms in pain reporting (Bolton & Wilkinson, 1998). For instance, a 2-point change in pain rating has been determined to be clinically meaningful among subjects with low back pain (Childs et al., 2005). Soreness has previously been evaluated using similar survey methods to the NPRS (Brown et al., 1997; Lambert et al., 2002; Lau et al., 2015).

Because inflammation has been proposed to play a substantial role in adaptation and recovery from training (Schoenfeld, 2012), it is possible that some aspects of inflammatory responses may be observed by the athlete and monitored by support personnel over the course of long-term training. Prior laboratory research has identified the relationship between increased training load and inflammatory activity in weightlifters (Storey et al., 2016), which may be reflected by subjective soreness and other qualities. Therefore, the purposes of this study were to observe changes in subjective physical sensations of pain and soreness over the course of a training cycle in weightlifters and to evaluate the relationships of these sensations to training load derived from primary lifts.

TABLE 1. Athlete characteristics

Athlete	Sex	Age (y)	Body Mass (kg)	Snatch (kg)	Clean and Jerk (kg)
1	Male	19	84	116	145
2	Male	18	69	100	127
3	Male	22	104	126	169
4	Female	20	58	59	75
Group		20±2	79±20	100±30	129±40

Notes: Group data are presented as mean ± SD.

METHODS: Three males and one female club-level weightlifters provided informed consent to participate in this study (refer to Table 1). A block-periodized training regimen was used for 3 days per week over a three-month period. The weightlifters reported physical sensations using a questionnaire (Figure 1) that was completed prior to each training session to reduce measurement error and conscious bias (Baldwin, 1999). Athletes used a scale ranging from 1-10 (minor to severe, respectively), similar to the NPRS, to report subjective pain and soreness for the affected body part. In addition, participants also reported if they modified their training or daily activities due to an injury. For example, if an athlete experienced a low degree of pain (2) and a moderate level of soreness (5), with some modification of daily activity (M), they would draw a line to the affected body part on the picture and write P2S5M. Researchers reviewed the questionnaire prior to initiation of the training session. If an athlete reported pain, they were directed to the sport medicine department for evaluation or treatment. Reports of M were used to indicate the necessity of sport medicine treatments and to determine with their coach if any training modifications were necessary. Only 1 athlete reported M for a brief period due to an injury over the course of this study. The questionnaire information was then transferred to a spreadsheet that was organized for each body part and each sensation by date.

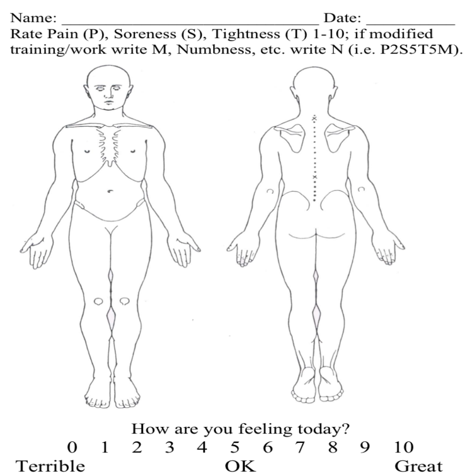

FIGURE 1. Monitoring questionnaire

The volume loads from select primary lifts: back squat, front squat, clean deadlift, clean pull, power clean, clean and jerk, snatch deadlift, power snatch, and snatch (load x sets x repetitions) (PVL), but not accessory lifts, were recorded by the athletes during the training sessions and reported to a researcher. Training spanned over the course of three months and included multi-week phases sequentially emphasizing strength-endurance (StrEnd) (e.g., sets of 10 repetitions), strength (Str) (e.g., sets of 5 repetitions), and strength-power (StrPwr) (e.g., sets of 3 repetitions). Frequency of each athlete's reported pain and soreness values were calculated and compared between each training phase. Data from only the body segment of the lower back to the knee (low back, glutes, hip flexors, posterior thigh, lateral thigh, medial thigh, anterior thigh, and knee) were included in this study due to greater frequency of responses by the participants. These data were compared to reported PVL for each phase of the training cycle (Figure 2). Effect sizes of the PVL from each phase were calculated using the formula provided by Rhea (2004). Because this was a pilot study, the most stringent criterion for evaluation of effect sizes (highly trained) was selected. Magnitude of effect sizes was evaluated using the following scale: <0.25 (trivial), 0.25-0.5 (small), 0.5-1.0 (moderate), and >1.0 (large) (Rhea, 2004). Spearman rankorder correlations were used to assess the relationships between individual athletes' longitudinal PVL with summed P and S data, respectively ($p = 0.05$). Hopkins' criteria were selected for the evaluation of correlation magnitudes (Hopkins, 2002). The data were analyzed using Microsoft Excel (Redmond, WA, USA) and JASP (version 0.9.1.0). This project was approved by LSU-Shreveport's Institutional Review Board.

TABLE 2. Effect sizes of changes in primary volume load across each training block

Athlete	StrEnd to Str	Str to StrPwr	StrEnd to StrPwr
1	-1.53***	-3.23***	-2.16***
2	-1.56***	-0.36*	-1.78***
3	-2.03***	-0.66**	-2.31***
4	-2.58***	-0.88**	-4.41***
Group	-1.46***	-1.12***	-1.88***

*Notes: ***= large effect size; **-moderate effect size; *=small effect size. StrEnd=Strength Endurance; Str=Strength; StrPwr=Strength-Power*

RESULTS: Non-significant relationships were observed longitudinally between each athletes' PVL and pain score (r_s ranged between 0.00 and 0.30, $p > 0.179$), PVL and soreness score (r_s ranged between -0.171 and 0.196, $p > 0.394$). Effect sizes of group average PVL, and individual athletes PVL between training phases are provided in Table 2. Small Frequency and severity of survey data are provided in Figure 2.

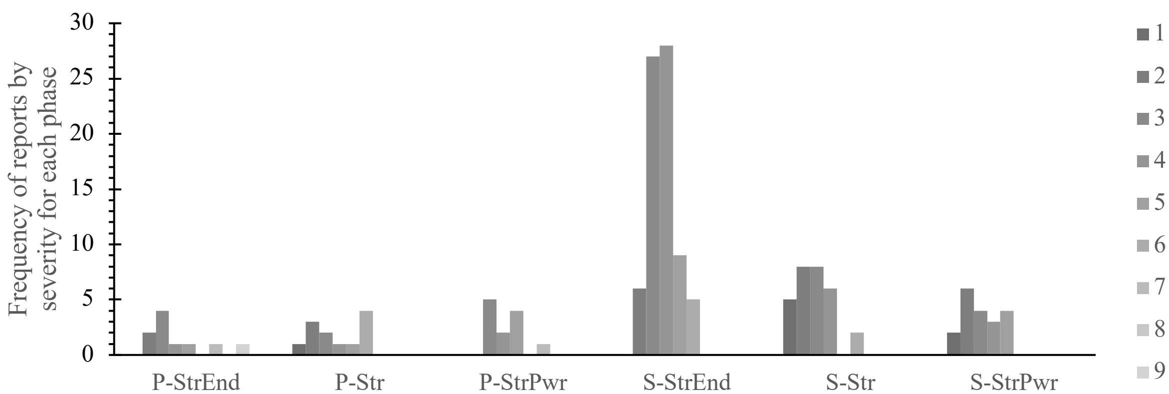

FIGURE 2. Frequency and severity of pain and soreness reports by training phase. The three categories on left are frequency of pain reports by strength endurance (StrEnd), strength (Str), and strength power (StrPwr). The three categories on right are frequency of soreness reports by strength endurance (StrEnd), strength (Str), and strength power (StrPwr). The column on the right is the key indicating severity of reported sensation.

DISCUSSION/PRACTICAL APPLICATIONS: The purposes of this study were to evaluate the changes in physical sensations of pain and soreness over a training cycle and investigate how these subjective scores related to PVL. Generally, large negative effect sizes indicated a significant reduction in training volume as the athletes progressed from StrEnd to Str to StrPwr emphases. Infrequent and very individual responses of pain were observed. None of these athletes met the criteria (+2 points) suggested by Childs and colleagues (2005) to indicate a significant increase in pain over the course of a training phase. No major changes in frequency of reported pain were observed between training phases.

Because soreness may reflect intracellular edema and processes of inflammation (Cheung, Hume, & Maxwell, 2003; Schoenfeld, 2012), it was interesting to observe that the largest number of soreness reports (75 total) occurred during the strength endurance phase. A reduced frequency of soreness reports was reported during the strength (29 reports) and strength-power (19 reports) phases, respectively. Increased S may be a result of greater muscle tension or damage (Cheung et al., 2003). Because soreness was substantially greater in the strength endurance phase, the results appear to be consistent with prior research on inflammation accompanying higher training volumes.

Based on the results of this pilot study, the present questionnaire appears to be an effective tool to observe changes in soreness experienced by club weightlifters over the course of a three-month training cycle. It may be recommended for use as a non-invasive, inexpensive, and time-efficient method of measuring muscle damage over the course of training. It is recommended to use other methods of monitoring in addition, in order to confirm trustworthiness of this tool for the individual athlete. If training outcomes are known (improvement, stagnation, injuries, etc.), it may be possible to relate adaptive responses to levels of reported soreness in many individuals in order to optimize the training stimuli for individual athletes and enhance programming tactics over a long-term period. Further research should investigate the use of this monitoring tool with a variety of athletic populations in long-term training. Inclusion of loads from all exercises performed appears to be required to detect any close relationships.

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