Injury in Australian female competitive gymnasts: A psychological perspective

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A nationwide sample of 162 Australian elite and non-elite competitive female gymnasts was administered a questionnaire to collect personal and training data, as well as information about injuries sustained in the previous 12 months. In addition, to assess the role of psychological variables in injury, the subjects were requested to complete measures of life stress, competitive anxiety, self-esteem, and locus of control. The sample reported 321 injuries, a rate of 1.98 injuries per gymnast (2.36 for the elite gymnasts and 1.83 for the non-elite gymnasts). It was found that for the overall sample and for the non-elite gymnasts, life stress was a significant predictor of injury. For the elite gymnasts, a more internal locus of control significantly predicted injury. The findings indicate the importance of the sports physiotherapist’s awareness of the role of stress both as a predisposing factor to injury and also as a variable that should be considered during the rehabilitation process.

Key words: Gymnastics; Psychology; Stress

There has been recent growth in participation rates in sporting and recreational activities (Requa et al 1993). In fact, it has been reported that, in the last decade, an increase in sports participation has been apparent in all Western countries at every age level (Backx et al 1989). This growth has resulted in the exposure of an increasing number of athletes to potential injury (van Mechelen et al 1992). According to de Loe and Goldie (1988) injury rates have reached serious proportions across a wide variety of sports, at both the elite and recreational levels, to the point of being described as a major public health problem.

The extent of this problem has been highlighted in Australia by a report to the National Better Health Program estimating that annual sports injuries number around one million. Furthermore, the direct medical costs of sports injuries in Australia for 1987-88 was estimated at $333-400 million, with a further $400 million being lost through absenteeism from work. A total of $1 billion in injury-related costs was predicted for 1990 and future years (Centre for Health Promotion and Research 1990).

Gymnastics is one of the sports that has experienced rapid growth and development and consequently an increase in participation (McAuley et al 1987). In addition to the rise in the number of gymnastics participants, children are entering the sport at a younger age (Caine et al 1989), exposing an increasing number of them to potential injury.

The injury rates reported for gymnasts have varied. However, investigations of competitive and elite gymnasts have consistently produced high rates. For example, Caine et al (1989) reported a rate of 294 per cent (ie 2.94 injuries per gymnast per year). A search of the literature revealed only two studies of Australian gymnasts (Dixon and Fricker 1993, Kolt and Kirkby 1995a). Both these investigations indicated similar findings. Dixon and Fricker (1993) reported a rate of 200 per cent for elite female and male gymnasts and Kolt and Kirkby (1995a) reported a rate of 198 per cent for elite female gymnasts.

Effective practice in sports physiotherapy requires an awareness of the factors causing injury in sport. This is especially pertinent in an activity such as gymnastics which, as described above, has been associated with high injury rates. These levels of injury appear to be markedly higher than in most other sports. As Kron (1993)
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pointed out, the findings of Kolt and Kirkby revealed that gymnasts were more vulnerable to injury than participants in sports such as football, that have been traditionally viewed as high injury activities.

Previously it has been assumed that external factors such as inadequate physical preparation, poor coaching practices, experience level of the participant, environmental variables, incorrect use of sporting equipment, and the contact and aggressive nature of some sports have been the major causes of sports injuries (May and Sieb 1987). However, when these issues have been addressed by way of rule alterations, improvements in safety and protective equipment, training practices and coaching techniques, and medical care, the number of injuries sustained by athletes has still risen (Nideffer 1989). Therefore, such external causes alone do not fully explain the phenomenon of sports injuries. This suggests that other potential mediators, such as psychological factors, may play a role in the vulnerability of athletes to injury (Kirkby 1995).

A wide range of psychological factors have been investigated in relation to the predisposition to injury in sport. These have included life stress, anxiety, self-confidence, locus of control, attention, cognitive mood states, coping mechanisms, motivation and personality (see reviews by Kirkby 1995, May and Sieb 1987, Nideffer 1989). Although it is not the purpose of this paper to review all of these areas, some of the variables that appear to be particularly pertinent to injury in gymnastics should be examined. For example, a recent investigation of competitive gymnasts in Australia (Kolt and Kirkby 1994) indicated that gymnasts who were more commonly injured were more likely to report higher levels of fatigue and anxiety than were their less-injured counterparts. In another study of injury, Kolt and Kirkby (1991) compared more-injured and less-injured gymnasts using the Ways of Coping with Sport Questionnaire (Madden et al 1990), a measure of coping styles in sport. They found that the more-injured gymnasts could be discriminated from the less-injured competitors by their greater use of "denial" and their lesser use of "increased effort and resolve" to cope with problems of poor performance.

One area that has produced relatively consistent findings in relation to sports injury has been research on life stress (see review by Kirkby 1995). Research in this area has focused predominantly on the hypothesis that athletes who are required to adapt to increased life changes are more likely to suffer injury. A search of the literature revealed only three investigations of life stress and injury in gymnastics. Two of these (Kerr and Minden 1988, Petrie 1992) looked exclusively at gymnastics participants while the other (May et al 1985) included gymnasts in a general sample. The results of these studies showed a relationship between injury and higher levels of life stress, confirming the results of investigations involving contact sports (see review by Kirkby 1995).

In view of these findings, the present investigation was carried out with the aim of determining the relationship between injury and psychological variables (life stress, anxiety, locus of control and self-esteem) in Australian elite and non-elite female gymnasts.

Method

Subjects

The subjects were 162 female competitive gymnasts, ranging in age from 9 to 18 years (mean [SD] 12.6 [2.0] years). The sample included two groups. The first group comprised 47 elite gymnasts (mean [SD] 11.3 [1.9] years) who had been identified and targeted by the Australian Gymnastic Federation as potential candidates for the national team, and in particular, the 1996 and 2000 Olympic Games. These gymnasts were training between 21 and 37 hours per week (mean [SD] 31.1 [3.6] hours), on five to six days per week at high performance training centres set up at several locations throughout the country by the state sports institutes and the Australian Gymnastic Federation. Gymnasts in this group had high rankings and included current members of national teams. The remaining subjects, classified as non-elite, consisted of competitive gymnasts (mean [SD] age 13.1 [1.8] years) training between six and 30 hours per week (mean [SD] 17.0 [4.6] hours), on two to six days per week at gymnastics clubs affiliated with the Australian Gymnastic Federation. These gymnasts were competing at a state and national championship level, but in a stream which excluded the elite gymnasts.

The study was nationwide; subjects were drawn from 18 centres spread throughout the five mainland states and one territory of Australia.

Test instruments

The subjects were requested to complete a test package. This included a questionnaire to collect personal data (eg age, extent of training), an inventory to record all injuries that had been incurred in the previous 12 months, and measures of life stress, anxiety, self-esteem, and locus of control.

Life stress was assessed with the Coddington Life Events Record (LER). This inventory was adapted by Coddington (1972a and 1972b) from the Social Readjustment Rating Scale (Holmes and Rahe 1967) to measure the degree of life change experienced by children. The inventory is made up of 40 events (eg divorce of parents). Respondents are requested to indicate which events they had experienced in the previous 12 months. The final life stress score is obtained by summing all the "life change units" (values indicating the amount of social readjustment required for each event) associated with the various events experienced. The LER has been shown to have high reliability (Coddington 1972a).

The Sport Competition Anxiety Test for Children (SCAT-C), developed by Martens et al (1990), was used to measure anxiety. It has been used widely to measure sport-specific competitive trait anxiety in children as...
young as 10 years (see review by Martens et al 1990). The inventory is made up of 15 items (e.g. “before I compete I am nervous”) rated on a 3-point Likert-type scale ranging from “hardly ever” to “often”. The SCAT-C has been shown to have reliability as high as 0.81, and internal consistency ranging from 0.95 to 0.97 (Martens et al 1990).

Self-esteem was assessed by the Coopersmith Self-Esteem Inventory (SEI), an instrument developed by Coopersmith (1967) to measure evaluative attitudes toward the self in social, academic, family, and personal areas of experience. The SEI is made up of 58 items (e.g. “I have a low opinion of myself”) requiring a response of “like me” or “unlike me”. The SEI has been reported to have a test-retest reliability of 0.82 with high levels of construct and concurrent validity (see review by Coopersmith, 1985).

Locus of control was measured with the Children’s Nowicki-Strickland Internal-External Control Scale (CNSIE). This scale was developed by Nowicki and Strickland (1973) as a child-specific measure of locus of control. This instrument assesses locus of control on an internal-external continuum. Internal locus of control indicates a belief that internal factors, such as hard work, will account for outcomes, whereas external locus of control indicates a belief that external factors, such as luck or fate, determine outcome. The CNSIE comprises 40 questions (e.g. “do you feel that most kids are just born good at sports”) each requiring a yes or no response. Reliability of the CNSIE has been reported to be high and it has been found to have moderate convergent validity with other locus of control measures (see review by Nowicki and Duke 1983).

Table 1. Means (X) and standard deviations (SD) of the LER*, SCAT-C*, SEI*, and CNSIE*

<table>
<thead>
<tr>
<th>Scales</th>
<th>Total Sample (N = 162)</th>
<th>Elite Gymnasts (n = 47)</th>
<th>Non-elite Gymnasts (n = 115)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>SD</td>
<td>X</td>
</tr>
<tr>
<td>LER</td>
<td>219.2</td>
<td>200.9</td>
<td>191.2</td>
</tr>
<tr>
<td>SCAT-C</td>
<td>22.5</td>
<td>4.6</td>
<td>22.4</td>
</tr>
<tr>
<td>SEI</td>
<td>74.1</td>
<td>15.4</td>
<td>75.7</td>
</tr>
<tr>
<td>CNSIE</td>
<td>12.8</td>
<td>4.6</td>
<td>12.7</td>
</tr>
</tbody>
</table>

*Square root transformations of the Coddington Life Events Record.
*Sport Competition Anxiety Test for Children.
*Coopersmith Self-Esteem Inventory.
*Children’s Nowicki-Strickland Internal-External Control Scale.

Results

The mean scores for the LER, SCAT-C, SEI, and CNSIE are shown in Table 1.

A standard multiple regression analysis was performed for the total sample between number of injuries (for full details of injury data see Kolt and Kirkby 1995a) as the dependent variable and scores on the LER, SCAT-C, SEI, and CNSIE as independent variables. The assumptions for regression analysis were evaluated and led to transformation of one of the variables (square root transformation of the LER score) to reduce skewness in its distribution. As well, the data were checked for normality, linearity, homoscedasticity of residuals, and outliers. No cases had missing data and no suppressor variables were found.

Table 2 shows the correlations between the variables, the unstandardised regression coefficients (B) and intercept, the standardised regression coefficients (β), the multiple correlation coefficient (R), and adjusted R². R for regression was significantly different from zero, F(4,157) = 4.375, p = 0.002. For the one regression coefficient (LER) that differed from zero, 95 per cent confidence limits were calculated. The confidence limits for square root of LER scores were 0.039 to 0.118.

Thus, only one of the independent variables contributed significantly to prediction of the number of injuries sustained by the gymnasts, square root of LER scores (R² = 0.087), accounting for 8.7 per cent of the variability. Altogether, only 10 per cent (7.7 per cent adjusted) of the variability in informed consent for parents or guardians) were distributed and completed by the gymnasts. Initially, 166 gymnasts were recruited. However, as four did not fully complete their questionnaires, they had to be excluded from the study. This gave a response rate of 97.6 per cent.
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number of injuries sustained by the gymnasts was accounted for by the four independent variables.

To further investigate the data, the scores of the elite and non-elite gymnasts were analysed separately. Thus, two further standard multiple regression analyses were performed using the same predictor variables: one on the scores of the elite gymnasts and one on those of the non-elite group.

For the 115 non-elite subjects, $R$ for regression was significantly different from zero, $F_{(4, 110)} = 4.314, p = 0.003$. For the one regression coefficient (LER) that differed from zero, 95 per cent confidence limits were calculated. The confidence limits for square root of LER scores were 0.038 to 0.130. Only one of the independent variables contributed significantly to prediction of the number of injuries sustained by the non-elite gymnasts, square root of LER scores ($r^2 = 0.104$), accounting for 10.4 per cent of the variability. Altogether, only 13.6 per cent (10.4 per cent adjusted) of the variability in number of injuries sustained by the non-elite gymnasts was accounted for by the four independent variables.

For the 47 elite gymnasts, $R$ for regression was significantly different from zero, $F_{(4, 42)} = 2.961, p = 0.031$. For the one regression coefficient (CNSIE) that differed from zero, 95 per cent confidence limits were calculated. The confidence limits for CNSIE scores were 0.015 to 0.142. This indicated that only one of the independent variables contributed significantly to prediction of the number of injuries sustained by the non-elite gymnasts, locus of control scores ($r^2 = 0.139$), accounting for 13.9 per cent of the variability. Altogether, the four independent variables combined accounted for 22.0 per cent (14.6 per cent adjusted) of the variability in number of injuries sustained by the elite gymnasts.

Discussion

The results of the present investigation showed that, for both the overall sample and the non-elite gymnasts, injury could be significantly predicted by life stress scores (ie gymnasts with higher life stress scores were more likely to be injured). For the elite gymnasts, scores on the locus of control scale significantly predicted injury (ie more internal locus of control scores were associated with injury).

The life stress findings of the present study support the earlier investigations of Kerr and Minden (1988) with a sample of 41 elite Canadian gymnasts (mean age 14.5 years) and Petrie (1992) with a sample of 193 female college-level gymnasts (mean age 18.9 years).

One explanation of these findings lies in a model of stress and sports injury proposed by Andersen and Williams (1988). Andersen and Williams outlined three broad categories of variables hypothesised to influence the stress response. The first category related to aspects of personality such as trait anxiety, locus of control beliefs, achievement motivation, hardness, and sensation-seeking characteristics.

These factors were hypothesised to influence the cognitive appraisal of stressors which, in turn, can directly affect the stress response. The second category of variables included a history of stressors, including life events and past injuries. The final component of the model related to the individual's coping resources such as social support and stress management skills, which can moderate the effect of life stress on psychological and physical outcomes.

Andersen and Williams suggested two basic mechanisms underlying the link between stress and injury: increased muscle tension and attention deficits. That is, an individual who is experiencing high levels of stress has personality traits that intensify or do little to ameliorate the stress response, and furthermore, has relatively few coping resources, is more likely to be in a state of increased muscle tension and/or to be distracted from the task at hand, and thus is more vulnerable to risk of injury.

When the data from the elite gymnasts were analysed separately,
locus of control (one of the variables in the first category of the Andersen and Williams model) was the only psychological variable that approached significance in predicting injury (ie, more internal locus of control was associated with injury). Notwithstanding that at the adjusted alpha level, this variable only indicated a trend towards significance, it could be that these gymnasts with a more internal locus of control, believing that success is more likely to come from themselves to a greater risk of injury. Furthermore, given the high levels of life stress that have been reported by elite gymnasts (Kolt and Kirkby 1995b), that life stress was not a significant predictor of injury in this group could be explained by the possibility that, as a consequence of their disciplined training and dedication to the pursuit of excellence, elite gymnasts have developed coping resources (the final component of the Andersen and Williams model) to deal with the negative effects of life stress that can precipitate injury.

A potential concern regarding the present investigation was the size of the sample of elite gymnasts. While it could appear that the number of elite gymnasts in the present study was relatively small it must be noted that this sample comprised approximately 50 per cent of the total population of elite gymnasts in Australia and involved competitors from all regions of the country. A final point about the present study concerns the retrospective procedure used to collect injury data. Notwithstanding that many investigators have used retrospective surveys to collect information about sports injuries (eg Dixon and Fricker 1993, Kerr and Minden 1988), asking a subject to review past events (injuries) involves the risk of retrospective contamination (Brown 1974), in which the reporting of previous events is often exaggerated in order to explain subsequent difficulties. It is possible that the gymnasts in the present study over-reported past injuries to account for recent difficulties or performance problems. Conversely, retrospective assessments are also open to problems of memory recall in which the more minor events (injuries) might not be remembered and therefore not recorded. This introduces a possible component of under-reporting of injury data. Thus it could be valuable in future studies to replicate this investigation using a prospective technique to gather data about injuries.

Conclusions

There were two particular aspects of the present study of importance to physiotherapists. The first of these was the link between life stress and injury in gymnastics. For the effective practice of sports physiotherapy, it is important to be aware of causal factors of sports injuries, not only from a physical viewpoint but also from the perspective of psychological factors. The physiotherapist should be aware of the association between life stress and injury and consider this link when establishing causes of injury and approaches to rehabilitation. It could be that teaching injured sportspeople techniques to cope with life stress reduces the risk of further injury. In more general terms, this suggestion has supported the previous report by Pearson and Jones (1992) that physiotherapists should consider psychological factors, as well as physical variables, when constructing rehabilitation programs for injured sportspeople and when communicating with their patients. This approach has also been recommended by other researchers investigating the role of physiotherapists in managing injured athletes (Gordon et al 1991, Horsley 1995).

The second aspect was the association between internal locus of control and injury in the elite gymnasts. The fact that gymnastics participation at elite levels involves intense training over long hours is likely to attract those athletes with an internal locus of control. With this in mind, it could be that modifying workout schedules to improve the efficiency of training might reduce the risk of injury.

These findings have important implications, not just for athletes in maintaining and improving national and world rankings but also for sport medicine professionals in the monitoring of injuries and in implementing preventative programs aimed at reducing the risk of injury in gymnastics.

Acknowledgments

Preparation of this article was supported in part by Physiotherapy Research Foundation Grants 005/91 and 021/92 to Gregory Kolt, and the project was endorsed by the Australian Gymnastic Federation. The authors gratefully acknowledge Jeremy Cass and Helen Lindner for their assistance in the preparation and analysis of the data. Thanks are also extended to the gymnasts and gymnastics officials who, through their cooperation, enabled this study to be carried out.

References


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