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RELEVANCE OF THE KÜBLER-ROSS MODEL TO THE POST-INJURY RESPONSES OF COMPETITIVE ATHLETES

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ABSTRACT

Attempts to explain and/or predict the post-injury responses of competitive athletes have relied upon current models of grief. Kübler-Ross's stage model (1969) has been particularly popular among sports psychologists and is cited frequently in sports psychology literature. Since the model was based upon a very different subject population, its relevance to the post-injury responses of competitive athletes has been questioned. This study evaluated the relevance of the model to the post-injury responses of competitive athletes. An existing database was utilised; the sample consisted of athletes (N=21) who, through injury, could not participate in sport for a minimum duration of two months. The sample represented various ethnic groups, with ages ranging from 12 to 35 years. Participation levels ranged from provincial to international. Through qualitative analysis, post-injury responses most similar to Kübler-Ross's (1969) grief responses were identified. Results indicate the frequent existence of post-injury responses similar to the grief responses proposed by Kübler-Ross (1969), with the exception of the bargaining response. The model also proved to be relevant in the identification of underlying tendencies occurring during the post-injury rehabilitation period.

Key words: Kübler-Ross; Post-injury responses; Sport injuries; Professional athletes; Grief stage model

INTRODUCTION

Athletic injury is essentially a negative experience with potentially far-reaching personal and financial implications. There is a tendency among medical and paramedical personnel to dwell upon the physical dimensions of an injury. As of late, medical professionals have come to realise the importance of incorporating psychological strategies into rehabilitation (Wagman & Khelifa, 1996; Crossman, 1997; Walker *et al.*, 2007).

Attempts to comprehend and eventually predict the nature of post-injury responses in athletes have relied heavily on existing theoretical models of grief. Among these, the stage theory of Kübler-Ross (1969) has been a popular frame of reference among sport psychologists, perhaps due to the fact that it remains one of the better-known theories on grief (Walker *et al.*, 2007).

The application of a theory of grief to the experience and consequences of athletic injury affords the opportunity to ask relevant questions. Does athletic injury constitute a loss and can post-injury responses be regarded as responses of grief? Bowlby's (1991) attachment theory offers a framework for understanding loss through injury. Bowlby (1991) suggests that injury threatens important attachments in terms of bodily function, self-image, self-esteem, the context of important relationships and the basis of many forms of gratification. In terms of this theory, athletic injury may pose a likely threat to the healthy equilibrium of these concepts.

In terms of the equation of post-injury responses to grief-like responses, Engel (1964) suggested that grief occurs as a result of the loss of anything that a person has come to consider as part of his or her natural environment and a source of psychological gratification.

The current research therefore focused on the extent to which the post-injury responses of athletes are similar to responses proposed by Kübler-Ross (1969) during stages of grief and on the resulting implications for the applicability of this model.

Models of grief within sport-related literature

The importance of psychological factors in the rehabilitation of injured athletes has become an increasingly relevant topic in sport-related literature (Evans & Hardy, 1995; Johnson, 1997; Brewer, 1999.) In the past, several studies have focused on the athlete's post-injury reactions. Chan and Grossman (1988) found that when comparing injured runners with non-injured runners, injured runners presented with significantly more depression, confusion and tension as well as lower self-esteem on various measurement instruments. Results of a study by Pearson and Jones (1992) suggested a significantly higher incidence of depression and anger among injured athletes. Depression scores for athletes with severe injuries were also 13 times higher than for athletes with minor injuries.

In a comparison between injured athletes and a control group, Leddy *et al*. (1994) found injured athletes to have significantly higher levels of state anxiety (tension) and that injured athletes had higher levels of depression and lower self-esteem scores than non-injured and recovered athletes.

Attempts to explain or predict the post-injury responses of athletes have led to the application of grief response models to the post-injury and rehabilitation phase (Quackenbush & Crossman, 1994). Kübler-Ross's (1969) five-stage model of the grief process, the results of which were drawn from over 200 interviews with terminally ill patients, is one upon which sport psychologists appear to have based their comparisons and assessments of the nature of grief responses during the post-injury phase (Evans & Hardy, 1995). Some of the first authors to contemplate the application of grief-related models to sport psychology were Gordon (1986) and Pederson (1986). They discussed the hypothesis that athletes may exhibit grief responses subsequent to sports injury.

The work of Kübler-Ross (1969) has been popularised since its inception, proposing a sequence of five stages of grief that are supposedly widely encountered among the bereaved.

The first stage is characterised by denial and isolation, during which patients may deny the reality of the diagnosis and/or prognosis of their condition. Kübler-Ross (1969) reports the function of denial as that of serving as a buffer, which affords the patient time for recollection and for the possible mobilisation of other psychological defences. As part of this first stage, isolation was strongly related to the extent to which patients subjectively experienced a lack of empathy and support from significant others.

Anger seems to be the predominant response in the second stage, where patients often direct their anger toward the clinician, hospital staff, family and friends, or at themselves. During the subsequent stage there is a tendency for patients to bargain, wanting to fulfil several pledges in return for a possible cure. Bargaining may often have a religious focus and is mostly kept secret or disclosed only to those deemed trustworthy. According to Kübler-Ross (1969) the postponement of accepting the inevitable supplies the highest level of energy to the bargaining process.

Depression follows as the fourth stage in the bereavement process. During this stage Kübler-Ross (1969) differentiates between an initial reactionary depression, followed by a preparatory kind of depression, with the latter serving as a tool to facilitate the acceptance of the impending losses, be it of loved objects or loved ones. Although Kübler-Ross (1969) does not explicitly elaborate on the symptoms of depression, these could be implied as being the manifestation of several clinical signs of depression, including social withdrawal, psychomotor agitation, hopelessness, tearfulness, insomnia and even suicidal ideation (Kaplan & Sadock, 1998).

The final stage constitutes the acceptance of the prognosis and eventual outcome of the illness.

The stage model proposed by Kübler-Ross (1969) seems to display contextual similarities with other models of grief referred to by sport psychologists. Averill (1968) and Karl (1987) proposed stage models of their own, essentially differing from Kübler-Ross's (1969) five-stage model only in the number and inclusiveness of their stages.

Loss through injury in the context of grief-related literature

For athletes who diligently invest in training and professional participation, any event which threatens their ability to function in an athletic role may constitute a significant personal loss (Brewer, 1999). In this respect Kübler-Ross's (1969) model affords a means by which loss through injury could be contextualised.

Malt (1992) verified the occurrence of emotion focused adjustment after an injury, a tendency confirmed by Smith (1996), who suggests that injury in athletes is often accompanied by depressive symptoms, low self-esteem, tension and anger – representing at least two of the stages proposed by Kübler-Ross (1969). According to Smith (1996) there also seems to be a relation between the incidence of mood disturbances in athletes and their personal progress in rehabilitation, with mood being inversely related to attendance of rehabilitation sessions. This evidence supports the relation between post-injury mood state in athletes and their perceived

loss of control, possibly lending support to the hypothesis of Kübler-Ross (1969) that anger might serve to regain a subjective feeling of control.

The tendency for post-injury responses to resemble grief-like responses was elaborated upon in an earlier study by Blinde and Stratta (1992), who undertook an in-depth investigation into the psychological reactions of athletes following an involuntary and unexpected exit from participation in sport at professional level. Athletes in this sample of 20 experienced the exit as traumatic and reported emotional experiences similar to the loss of someone with whom they had a close relationship.

Blinde and Stratta (1992) also equated post-injury responses to the stage theory of Kübler-Ross (1969), making specific mention that, among other factors that could lead to an early career exit, athletic injury remains one of the causative factors related to the existence of grief-like emotional reactions. Blinde and Stratta (1992) also argue that despite criticism against the application of the Kübler-Ross (1969) model, her stage theory could still be instrumental as a frame of reference for a better understanding of the psychological factors at play during the exit process. They also indicated that depression, i.e. stage four in the Kübler-Ross (1969) model, seems to be the most prolonged stage experienced by athletes after an unexpected exit from professional participation.

Injury and the loss of athletic identity

The loss of athletic identity seems to be a primary consequence of athletic injury, especially when retirement from professional participation is indicated. Webb *et al*. (1998) argue that the nature of the reaction to retirement from participation seems to be dependent on two variables: the strength of the participant's athletic identity; and secondly, the circumstances that prevailed when retirement occurred.

Webb *et al.* (1998) also indicated that the post-injury athletic identity among the studied athletes was strongly associated with a sense of vagueness, reiterating the functional nature of an intact identity dependent on optimal physical condition. Whatever the underlying process, injury-related retirements seem more problematic to individuals with strong athletic identities.

RESEARCH DESIGN AND METHODOLOGY

Nel (1999) approached several sportsmen and women in collaboration with the sport bureaus of the University of the Free State and Central University of Technology, as well as local schools and sport clubs. The sample consisted of 21 participants who, as a result of injury, could not participate in sport for a minimum duration of two months. The participants were involved in different kinds of sport: a) low risk, no contact, individual or team; b) high risk, contact, individual; and c) team, contact. Ages ranged from 12 to 35 years, (average age = 21.67, SD = 6.24), representing different levels of competition, i.e. provincial, national and international. Eight females and 13 males were included in the study and various ethnic groups were represented.

Semi-structured interviews were conducted, affording the athletes the opportunity to elaborate retrospectively on their post-injury experiences throughout different phases of rehabilitation. The phases were identified as: 1) injury phase; 2) treatment decision-making and planning phase; 3) early rehabilitation phase; 4) late rehabilitation phase; and 5) return-to-competition phase (Nel, 1999).

The authors coded and analysed transcribed interviews to isolate the cognitive, emotional and behavioural responses of athletes during the different phases of rehabilitation. The latter was performed with the QSR NUD*ST software programme, designed specifically for the purpose of analysing and coding qualitative data.

Further qualitative exploration of these cognitive, emotional and behavioural responses was undertaken. The purpose was to isolate the post-injury responses most similar to the grief responses proposed by the Kübler-Ross (1969) model. Inferences made were verified by two independent researchers through triangulation, crediting the process with a higher degree of objectivity.

RESULTS AND DISCUSSION

Figure 1 highlights the distribution of post-injury responses for all athletes across all phases of rehabilitation. Eighty-one percent (81.0%) of all athletes experienced some form of denial, whilst 90.5% of the subjects experienced isolation during these phases. Post-injury responses of anger existed among a third (33.3%) of the subjects, whereas only one subject reported some form of bargaining. Indications of depression were found in two thirds (66.7%) of the subjects. Responses of acceptance were reported by 85.7% of the subjects. Although denial and isolation are noted separately, it should be taken into account that both still form part of the first stage proposed by Kübler-Ross (1969).

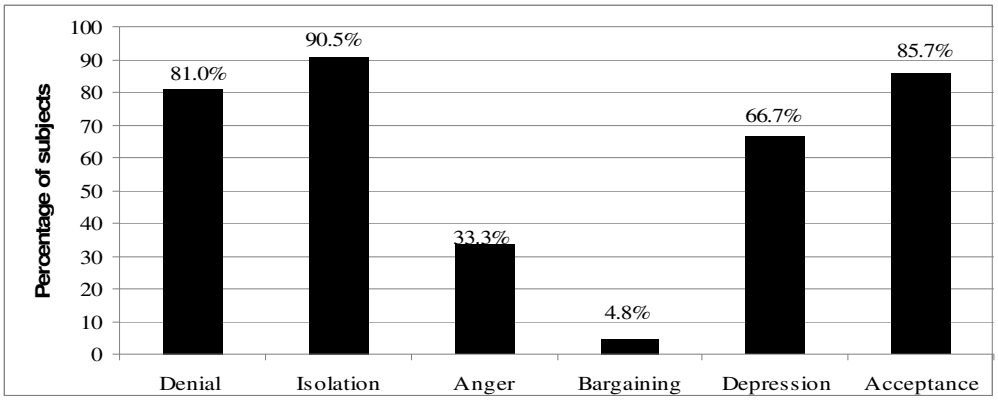

FIGURE 1: **POST-INJURY RESPONSES FOR ALL PHASES OF INJURY**

Injury phase

During the injury phase (Figure 2), the predominant post-injury responses were denial (38.1%) and depression (33.3%). No bargaining was reported and only one subject (4.8%) gave an indication of experiencing isolation. Three (14.3%) of the subjects reported acceptance during this early phase. Depression was indicated by responses such as the withdrawal from interpersonal contact, pronounced sadness and feelings of worthlessness, inappropriate guilt and feelings of dysphoria (unpleasant mood). None of the subjects who experienced anger (9.5%) in the injury phase reported any indications of acceptance in the same phase.

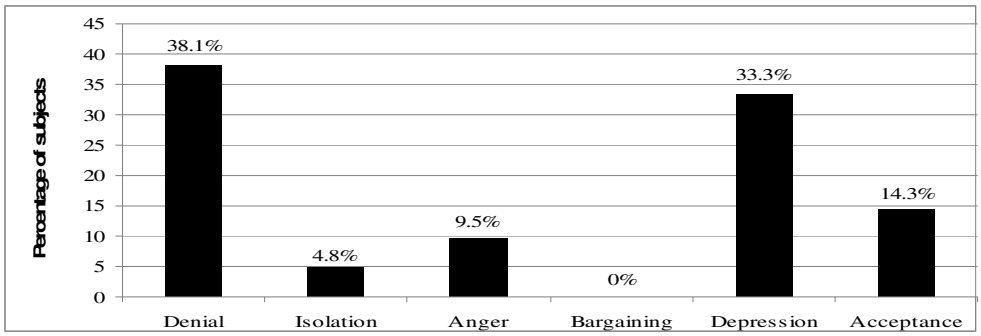

FIGURE 2: **POST-INJURY RESPONSES FOR THE INJURY PHASE**

Treatment decision-making and planning phase

Post-injury responses during the decision-making and planning phase (Figure 3) seem to differ significantly from the injury phase. None of the subjects reported anger and depression and there was also an absence of bargaining. There was an increase in reported acceptance (from 14.3% to 42.9%) and a decrease in denial. Athletes accepted medical and paramedical interventions considered (by them) to be appropriate for the type of injury, along with a professional opinion on the diagnosis. They also accepted time as a crucial factor in the rehabilitation process.

FIGURE 3: **POST-INJURY RESPONSES FOR THE TREATMENT DECISION-MAKING AND PLANNING PHASE**

A possible explanation for the absence of anger during this phase could coincide with the function ascribed to anger by Kübler-Ross (1969). Anger is often present in the individual who subjectively experiences a loss of control over his/her circumstances, as anger serves the function of regaining control. Involvement in the treatment decision-making and planning phase might afford the athlete a sense of regaining control within the rehabilitation process.

Early rehabilitation phase

The subsequent early rehabilitation phase (Figure 4) had the highest incidence of depression (52.4%). This phase also had the highest occurrence of anger (28.6%), possibly indicating a rise in the subjective loss of perceived control among athletes. Athletes reported experiencing anger due to a lack of understanding and empathy from significant others, e.g. immediate family and coaches. Some of them also experienced anger towards medical professionals for not being decisive enough in dealing with the injury.

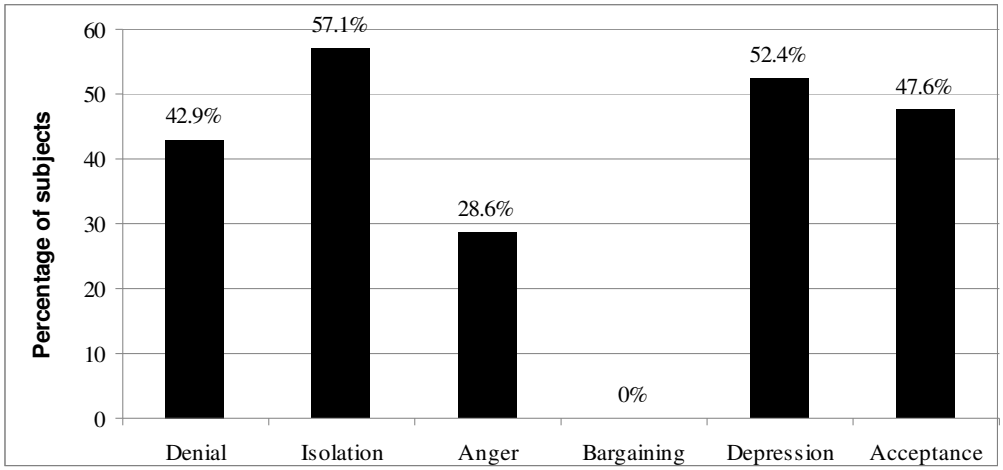

FIGURE 4: **POST-INJURY RESPONSES FOR THE EARLY REHABILITATION PHASE**

Reports of isolation increased considerably when compared to the previous phase in the rehabilitation process. More than half (57.1%) of the athletes reported feeling isolated during the early rehabilitation phase, compared to only one subject reporting feelings of isolation during the treatment decision-making and planning phase. This tendency continued into the late rehabilitation phase, indicating that athletes may experience these two phases as particularly difficult.

The incidence of acceptance is highest during the early rehabilitation phase. Nearly a third (28.6%) of the subjects accepted that rehabilitation was a gradual process and that adherence to the prescribed rehabilitation programme would yield the best results. The same percentage of subjects (28.6%) accepted the nature of the prognosis and that the pre- and post-injury performance levels might differ. There proved to be a rise in denial during the early rehabilitation phase. Similarly, almost a third (28.6%) of the subjects denied the existence of

emotional turmoil during early rehabilitation, with 14.3% denying the reality of the prognosis, or the probability that the injury would have a significant influence on future athletic performance.

Late rehabilitation phase

The late rehabilitation phase (Figure 5) was the only phase with a reported incidence of bargaining (4.8%), the nature of which was religious. The low incidence of bargaining could be explained in terms of the documented observation of Kübler-Ross (1969) that bargaining is rarely, if ever, disclosed, and then usually only acknowledged to trusted individuals. The possibility exists, therefore, that more subjects could have bargained during any of the phases of rehabilitation. As mentioned before, the incidence of isolation was still relatively high during the late rehabilitation phase (52.4%). The incidence of denial, anger and acceptance were significantly lower (roughly 50% less compared to the previous phase), whereas the incidence of depression decreased by 33% compared to the early rehabilitation phase. Since more than half of the athletes still experienced isolation, it is suggested that particular attention should be paid to the reported reasons for this tendency. More than a third (38.1%) of the subjects felt isolated from their training partners and experienced a lack of support from team management and coaches. They also reported insufficient support from their primary support structures (friends and family).

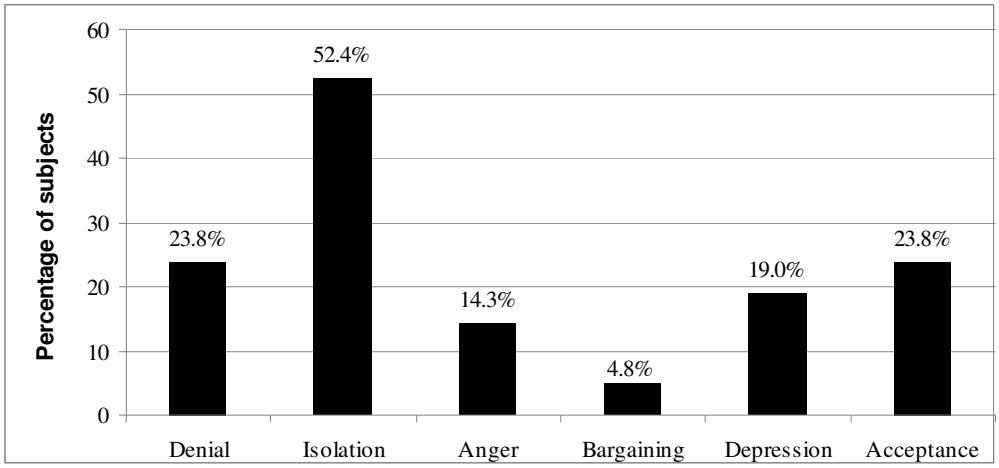

FIGURE 5: **POST-INJURY RESPONSES FOR THE LATE REHABILITATION PHASE**

Return-to-competition phase

The return-to-competition phase (Figure 6) differs significantly from the phases of early and late rehabilitation. There were no incidences of anger, bargaining or depression and there was a significant reduction in the incidence of isolation, probably indicative of the strong positive influence of becoming part of a joint exercise programme and the resulting higher frequency of social interaction. One athlete still indicated feelings of isolation, reporting that he felt

estranged from training partners and team members due to the loss of previous (pre-injury) levels of performance.

Acceptance during this phase of rehabilitation was related to two areas: 1) level of performance; and 2) rehabilitation of injury. Approximately a quarter (23.8%) of the athletes accepted that the level of performance would be at a significantly lower level than the pre-injury performance and one athlete (4.8%) accepted that the injury might not be fully rehabilitated and was still latent. Two athletes (9.5%) denied the severity of the initial injury and wanted a return to pre-injury levels of performance after rehabilitation.

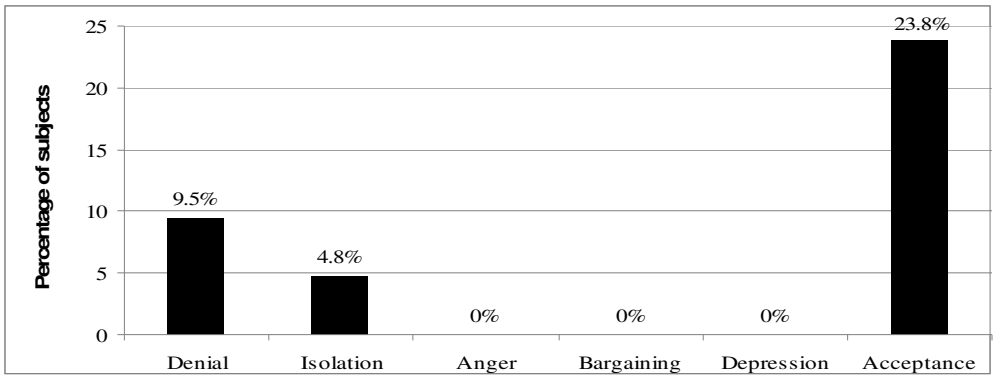

FIGURE 6: **POST-INJURY RESPONSES FOR THE RETURN-TO-COMPETITION PHASE**

Results are further illuminated when specific post-injury responses are viewed in terms of the different phases of injury (Figures 7 to 9). Responses of denial (Figure 7) were prevalent throughout all the phases and reached a peak (42.9%) during the early rehabilitation phase, whereas the lowest incidence rate occurred when the athletes returned to competition.

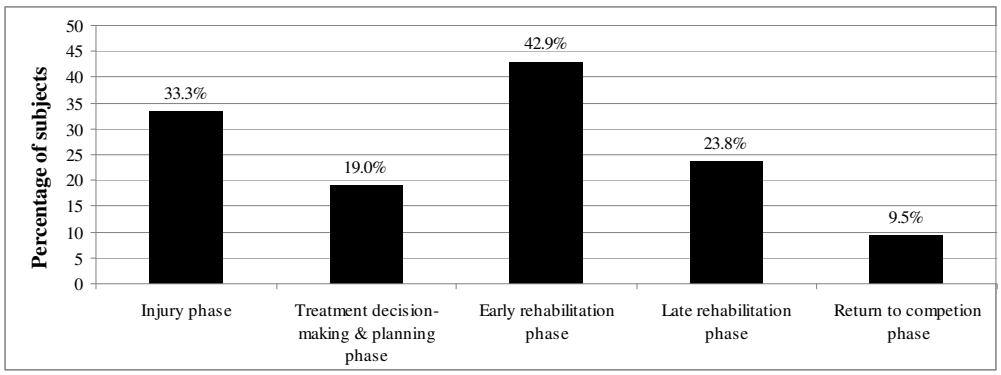

FIGURE 7: **RESPONSES OF DENIAL FOR ALL PHASES OF REHABILITATION**

Subjects reported the highest incidence of isolation during the early (57.1%) and late rehabilitation (52.4%) phases respectively (Figure 8). It could be hypothesised that factors accounting for isolation (i.e. support and empathy from team members, immediate family, friends and coaches) were still sufficiently present during the injury as well as the treatment decision-making and planning phases.

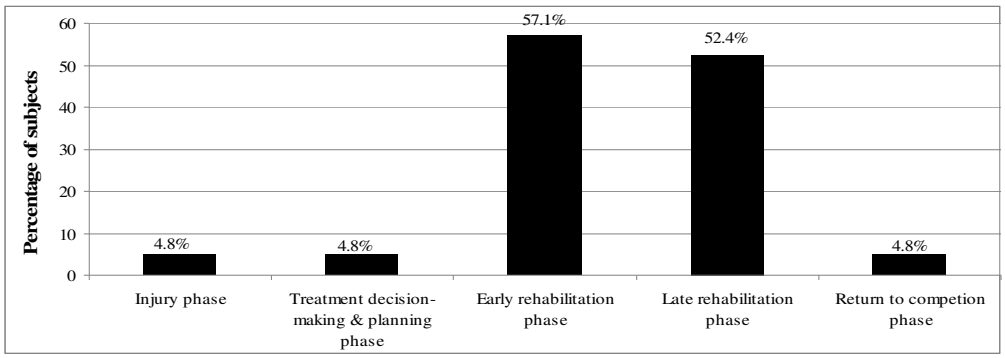

FIGURE 8: **RESPONSES OF ISOLATION FOR ALL PHASES OF REHABILITATION**

Depression (see Figure 9) existed across the span of three injury phases with a third (33.3%) of the athletes experiencing depression during the injury phase and approximately half of them (52.4%) feeling depressed during early rehabilitation. Almost a fifth of the subjects (19.0%) were still experiencing depression in the late rehabilitation phase. These results tend to confirm the findings of Blinde and Stratta (1992) who indicated that depression seems to be the most prolonged mood state experienced by athletes after an unexpected exit from professional sport.

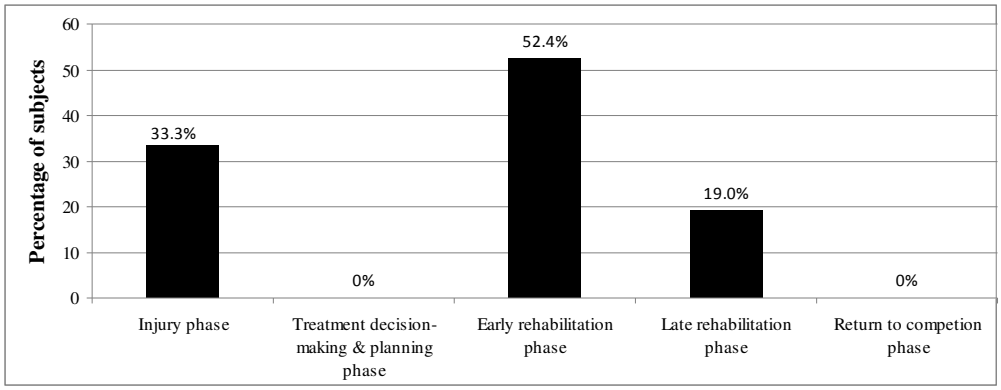

FIGURE 9: **RESPONSES OF DEPRESSION FOR ALL PHASES OF REHABILITATION**

SUMMARY

The highest incidence of isolation occurred during the phases of early rehabilitation and late rehabilitation respectively. The incidence of isolation during these phases was also considerably greater (approximately 10 times higher) than during any other phase of injury. The incidence of depression and anger peaked during the early rehabilitation phase. The simultaneous occurrence of isolation and depression accentuates athletes' susceptibility to mood instabilities during this period, especially in the absence of sufficient primary support.

The highest incidence of acceptance was also reported during the early rehabilitation phase. It should be noted, however, that the content of the reported acceptance was in relation to the nature of the rehabilitation process and not to the injury itself. Therefore, it cannot be inferred that athletes accepted the injury, but rather certain inevitable implications thereof.

The incidence of anger displays a gradual decline across the last three phases of rehabilitation, with its peak during early rehabilitation. This phenomenon might reflect a manifestation of Kübler-Ross's (1969) hypothesis that anger serves to compensate for a loss of control, thus indicating that the athlete might regain a sense of control during the final two phases of rehabilitation.

Depression similarly displays a diminishing incidence across the last three phases of rehabilitation (52.4% during the early rehabilitation phase to 0% during the return-to-competition phase). This tendency could represent the differentiation that Kübler-Ross (1969) makes between reactionary depression and depression over impending losses. The incidence of 33.3% during the injury phase might represent the reactionary kind of depression with its buffering function, affording the athlete time to recollect and mobilise other psychological mechanisms or sources of coping. The subsequent phase has no incidence of depression, with a high incidence again during early rehabilitation, when the athlete may realise the full impact of the loss. The depression then subsides as the progress of the rehabilitation process puts the losses into context, or as the athlete regains a sense of control.

The role of an intact athletic identity cannot be underestimated, as many of the subjects indicated that the loss of that identity contributed to the experience of isolation. Only one subject reported engaging in bargaining. Kübler-Ross (1969) indicated that bargaining is a rarely disclosed phenomenon.

CONCLUSIONS

The results of the study necessitate several suggestions to professionals involved in the post-injury rehabilitation of athletes. As evidenced by the study, the majority of injured athletes demonstrated pre-morbid mental health functioning within normal limits. The sudden loss of athletic ability and athletic identity will in many cases have a significant impact on the athlete's personal well-being and mental state functions.

The study indicates that the most difficult time for athletes was during the early and late rehabilitation phases, when they experienced a greater sense of isolation and had to anticipate or envisage their level of post-rehabilitation performance. It was also during this time when

follow-up support and interest from a coach and/or team manager/former training partner was most appreciated, as well as continued empathy from treating clinicians like physiotherapists, biokineticists and rehabilitation physicians. A lack of primary support during this time had been indicated to precipitate mood disturbances in this group of athletes.

The existence of an athletic identity relies heavily on optimal physique and athletic performance. An injury affects the foundation of that identity with a resulting demand on the athlete's ability to recollect and focus on the gradual restoration of athletic identity. This attempt can be especially difficult without the necessary empathy and professional support. Athletes often reported feelings of vagueness and worthlessness due to a sudden loss of athletic identity. Moreover, athletes who were part of a team often felt isolated and marginalised due to a sudden lack of any significant contribution to that team. When this coincided with financial loss, it often culminated in low mood and anxiety. Particular interest should be taken in the establishment of some form of continuity and follow-up with athletes in this category.

The post-injury responses of professional athletes bear resemblance to grief-like responses. The model of Kübler-Ross (1969) can, therefore, not be discarded as irrelevant, despite being originally based upon a very different subject population.

REFERENCES

AVERILL, J.A. (1968). Grief: Its nature and significance. *Psychological Bulletin*, 70: 721-748.

BLINDE, E. & STRATTA, T.M. (1992). The 'sport career death' of college athletes: Involuntary and unexpected sport exits. *Journal of Sport Behaviour*, 15(1): 3-18.

BOWLBY, J. (1991). *Attachment and loss: Volume 3. Loss, sadness and depression*. London: Penguin.

BREWER, B.W. (1999). Causal attribution dimensions and adjustment to sport injury. *Journal of Personal and Interpersonal Loss,* 4(3): 215-225.

CHAN, C.S. & GROSSMAN, H.Y. (1988). Psychological effect of running loss on consistent runners. *Perceptual and Motor Skills,* 66: 875-883.

CROSSMAN, J. (1997). Psychological rehabilitation from sports injuries. *Sports Medicine*, 23(5): 333-339.

ENGEL, G.L. (1964). Grief and grieving. *American Journal of Nursing*, 64: 93-98.

EVANS, L. & HARDY, L. (1995). Sport injury and grief responses: A review. *Journal of Sport and Exercise Psychology*, 17(3): 227-240.

GORDON, S. (1986). Sport psychology and the injured athlete: A cognitive-behavioural approach in injury response and injury rehabilitation. *Sport Science Periodical on Research and Technology in Sport*, 3: 1-10.

JOHNSON, U. (1997). A three-year follow-up of long-term injured competitive athletes: Influence of psychological risk factors on rehabilitation. *The Journal of Sport Rehabilitation*, 6(3): 256-271.

KAPLAN, H.I. & SADOCK, B.J. (1998). *Synopsis of psychiatry: Behavioural Sciences/Clinical Psychiatry*. Baltimore: Williams & Wilkins.

KARL, G.T. (1987). A new look at grief. *Journal of Advanced Nursing*, 12(5): 641-645.

KüBLER-ROSS, E. (1969). *On death and dying*. New York, NY: Macmillan.

LEDDY, M.H.; LAMBERT, M.J. & OGLES, B.M. (1994). Psychological consequences of athletic injury among high-level competitors. *Research Quarterly for Exercise and Sport*, 65(4): 347-354.

MALT, U.F. (1992). Coping with accidental injury. *Psychiatric Medicine*, 10(3): 135-147.

NEL, P. (1999). Sportlui se kognitiewe en emosionele belewing van beserings. Ongepubliseerde PhD proefskrif. Stellenbosch: Universiteit Stellenbosch.

PEARSON, L. & JONES, G. (1992). Emotional effects of sports injuries: Implications for physiotherapists. *Physiotherapy*, 78(10): 762-770.

PEDERSON, P. (1986). The grief response and injury: A special challenge for athletes and athletic trainers. *Athletic Trainer*, 21: 312-314.

QUACKENBUSH, N. & CROSSMAN, J. (1994). Injured athletes: A study of emotional responses. *Journal of Sport Behaviour*, 17(3): 178-187.

SMITH, A.M. (1996). Psychological impact of injuries in athletes. *Sports Medicine*, 22(6): 391-405.

WAGMAN, D. & KHELIFA, M. (1996). Psychological issues in sport injury rehabilitation: Current knowledge and practice. *Journal of Athletic Training*, 31(3): 257-261.

WALKER, N.; THATCHER, J. & LAVALLEE, D. (2007). Psychological responses to injury in competitive sport: A critical review. *The Journal of the Royal Society for the Promotion of Health,* 127 (4): 174-80.

WEBB, W.M.; NASCO, S.A.; RILEY, S. & HEADRICK, B. (1998). Athlete identity and reactions to retirement from sports. *Journal of Sport Behaviour*, 21: 338-362.

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