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ORIGINAL RESEARCH

Negative psychological responses of injury and rehabilitation adherence effects on return to play in competitive athletes: a systematic review and meta-analysis

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Abstract: Previous research offers evidence that psychological factors influence an injured athlete during the rehabilitation process. Our first objective was to conduct a systematic review and meta-analysis of the results from all published studies that examined the relationships among negative affective responses after sport injuries, rehabilitation adherence, and return to play (RTP). The second objective was to use a meta-analytic path analysis to investigate whether an indirect effect existed between negative affective responses and RTP through rehabilitation adherence. This literature review resulted in seven studies providing 14 effect sizes. The results from the meta-analysis showed that negative affective responses had a negative effect on successful RTP, whereas rehabilitation adherence had a positive effect on RTP. The results from the meta-analytic path analysis showed a weak and nonsignificant indirect effect of negative affective responses on RTP via rehabilitation adherence. These results underline the importance of providing supportive environments for injured athletes to increase the chances of successful RTP via a decrease in negative affective responses and increase in rehabilitation adherence.

Keywords: affective responses, rehabilitation behaviors, return to play, sport injuries

Introduction

Sport injuries are a major problem related to sport participation.[1–3] Research has shown that injuries can have major negative consequences on an athlete's athletic career (e.g., career termination)[4,5] and can severely affect his/her well-being.[6–8] Given the potential negative outcomes related to sport injuries, one important aspect of sport injury rehabilitation is to facilitate the rehabilitation process to increase the chances of a successful rehabilitation outcome. To better understand the factors that might influence both the rehabilitation process and the likelihood of return to play (RTP), several theoretical frameworks have been developed. One theoretical framework developed to explain responses to sport injuries and the recovery process following sport injuries is the dynamic biopsychosocial cycles of post sport injury response and recovery framework.[9] According to this framework, an athlete's interpretation of the situation of being injured will influence the magnitude of negative affective responses. The magnitude of negative affective responses is, in turn, suggested to influence an athlete's behaviors (e.g., rehabilitation adherence). An athlete's choice of behaviors will then be related to the rehabilitation outcomes (e.g., RTP). During the past 10 years, interest in psychological factors' influences on the rehabilitation process and outcomes has progressively increased. This increased interest has resulted in several published

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review articles.[10–15] One of the main conclusions of these reviews is that negative psychological responses can decrease the likelihood of a successful RTP.

In these review articles, however, only the direct effects of psychological variables on rehabilitation outcomes were examined; indirect effects have so far been neglected in the literature. This is a bit surprising because biological and rehabilitation behaviors have been suggested to mediate the relationship between psychological factors and rehabilitation outcomes.[9,13] Given the suggestion that behaviors (e.g., rehabilitation adherence) mediate the relationship between psychological factors (e.g., affective responses) and rehabilitation outcomes (e.g., RTP), it is of interest to test the empirical support for this assumption.

Our first objective was to conduct a systematic review and meta-analysis of the results from all published studies that examined the relationships between negative affective responses after a sport injury, rehabilitation adherence, and RTP. The second objective was to use a meta-analytic path analysis to investigate the indirect effect of negative affective responses on RTP through rehabilitation adherence.

Methods

Literature search

We searched the electronic databases of Science Direct, Web of Science, PubMed, and PsycINFO using combinations of the following keywords: "sport injury", "psychology", "return to play", and "return to sport". Boolean expressions and MeSH terms were used along with truncations adjusted to each database's guidelines. In addition, we searched published review articles for additional studies.[10–15]

Studies were considered for inclusion if: 1) they had used prospective or cross-sectional designs; 2) they were published in peer-review journals; 3) they were written in English; 4) the athletes were injured when the first psychometric data were collected; and 5) they investigated any of the relationships between negative affective responses, adherence to rehabilitation, and RTP. In our study, different criteria were used for data extraction. The specific negative responses that Wiese-Bjornstal[9] listed guided the selection of negative affective responses. For adherence to rehabilitation, subjective or objective reports on adherence to a prespecified rehabilitation plan were considered an inclusion criterion. RTP was defined as the length of time from the injury to the time when the athlete was playing sports again. One of the included studies, however, used a slightly different definition. Heredia et al[16] defined RTP as the length of time between the date when the athlete was declared medically fit and the date when the athlete returned to play. The Heredia et al study was, however, relevant to our research question and it was therefore included despite using a slightly different RTP definition. Effect sizes were calculated for relationships among the variables of interest (i.e., negative affective responses, adherence to rehabilitation, RTP). The full literature search process is illustrated in Figure 1, and a summary of all studies included in the meta-analysis is reported in Table 1.

An additional inclusion criterion was that the studies presented statistical data necessary for the calculation of zero-inflated Pearson's *r* effect sizes. Common reasons for the exclusion of studies were as follows: 1) the psychometric data were collected retrospectively, after the athletes had returned to sport activities; 2) the outcome variable was subjective knee function; and 3) the studies were review articles.

Meta-analytic procedures

By applying a meta-analytic procedure to a systematic review procedure, it is possible to collectively test a statistical synthesis of research findings. We used the zero-inflated correlation coefficients as effect-size estimates. In the calculation of the coefficients for the relationships among the three variables of interest, we first transformed all effect sizes to Fisher's *z* correlations. In the second step, we corrected the Fisher's *z* correlations by weighting the sample-size estimates. In the third step, we used the weighted

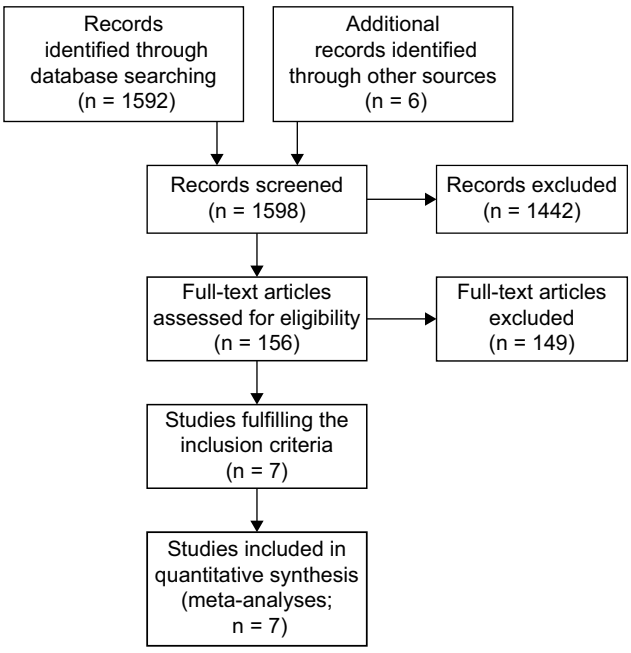

Figure 1 Description of the selection process for included studies.

Table 1 Overview of the studies included in the meta-analysis

Study	Design	Population	n	Injuries	Variables	Definition of RTP
Brewer et al[35]	Prospective study	Competitive and recreational athletes	95	Acute ACL injury	Negative responses, adherence	NA
Heredia et al[16]	Prospective study	Competitive athletes	20	All types of injuries	Negative responses, adherence, RTP	The period between the date when the athlete was declared medically fit and the data on which the athlete returned to play
Lentz et al[36]	Prospective study	Injured athletes	60	Acute ACL injury	Negative responses, RTP	RTP
Lu and Hsu[37]	Cross-sectional study	Collegiate student athletes	224	All types of injuries	Negative responses, adherence	NA
Müller et al[38]	Prospective study	Injured athletes	40	Acute ACL injury	Negative responses, RTP	RTP 7 months after surgery
Podlog et al[39]	Cross-sectional study	High-school students (study 1), collegiate athletes (study 2)	118 (study 1) 105 (study 2)	All types of injuries	Negative responses, adherence	NA
Shin et al[40]	Prospective study	Competitive athletes	40	All types of injuries	Adherence, RTP	RTP

Note: n, sample size.
Abbreviations: RTP, return to play; ACL, anterior cruciate ligament; NA, not available.

Fisher's *z* correlations to calculate the average Fisher's *z* correlation for the relationships among the three variables. Fourth, we transformed the average Fisher's *z* correlation into zero-inflated standardized correlation coefficients. For all calculations, we used the Comprehensive Meta-Analysis software.[17] The results are reported using mean effect sizes (*r*) or beta (β) values in combination with 95% confidence intervals (CIs). A result of $p < 0.05$ was considered to be statistically significant.

We used the I^2 statistic as a measure of heterogeneity among studies. The I^2 estimate indicates the degree of inconsistency among the magnitudes of the coefficients within each category of relationships. We calculated a fail-safe number (FSN) for each relationship tested in the meta-analysis. The FSN is used to indicate how many additional studies with mean null results would be needed to reduce the combined statistical significance to a specific alpha level (e.g., 0.05).

Both Wiese-Bjornstal[9] and Brewer[13] suggested that rehabilitation adherence potentially mediates the relationship between psychological variables and rehabilitation outcomes, and a meta-analytic path analysis is a useful approach for testing this proposed indirect association. To test the indirect effect of negative affective responses on RTP via rehabilitation adherence, we conducted a meta-analytic path analysis within a meta-analysis structural equation modeling (MASEM) framework.[18] Prior to the analysis, we inserted the zero-inflated correlation coefficients into a correlation matrix. Based on this correlation matrix, we used Mplus version 7.4[19] to conduct the path analysis. To test the indirect effect, the Sobel method with a 95% CI was used. In addition, in line with previous recommendations, we used the harmonic mean as the sample size in our analysis.[20]

Results

An overview of the study characteristics, heterogeneity assessment, and FSNs is provided in Tables 1 and 2. The results from the meta-analysis showed a negative and statistically significant relationship between negative affective responses after sport injury and RTP ($r = -0.32$, 95% CI [−0.42, −0.21]). Moreover, the relationship between rehabilitation adherence and RTP was positive and statistically significant ($r = 0.54$, 95% CI [0.34, 0.69]).

The results from the meta-analytic path analysis showed a statistically significant effect of negative affective responses on RTP (β = −0.26, 95% CI [–0.41, −0.12], $p < 0.001$). Also, a positive and statistically significant effect of rehabilitation adherence on RTP (β = 0.51, 95% CI [0.38, 0.64], $p < 0.001$) was found. Negative affective responses had a small and not statistically significant effect on rehabilitation adherence (β = −0.11, 95% CI [−0.29, 0.07], $p = 0.23$). Negative affective responses and rehabilitation adherence explained 36.0% of the variance in RTP, whereas negative affective responses explained 1.2% of the variance in rehabilitation adherence. The indirect effect of negative affective responses on RTP via rehabilitation adherence was small and not statistically significant (standardized estimate = −0.06, 95% CI [–0.15, 0.04], $p = 0.23$).

Table 2 Results of meta-analyses and homogeneity tests for the relationships between negative responses after injury, rehabilitation adherence, and return to sport

Relationship	*k*	n	Effect size (*r*)	95% CI	FSN	I^2 (%)
Negative responses–rehabilitation adherence	9	1058	–0.11	–0.15, 0.07	20	20
Negative responses–return to sport	3	120	–0.32	–0.42, –0.21	7	0
Rehabilitation adherence–return to sport	2	60	0.54	0.34, 0.69	NA	0

Notes: *k*, number of effect sizes; n, total number of participants.
Abbreviations: CI, confidence interval; FSN, fail-safe number; NA, not available.

Discussion

Both negative affective responses after injury occurrence and rehabilitation adherence had direct effects on RTP. More specifically, low levels of negative affective responses and high compliance with a rehabilitation program were associated with a higher likelihood of successful RTP. In addition, the results showed a weak, and not statistically significant, indirect effect of negative affective responses on RTP.

The negative effect of negative affective responses on RTP has been found in previous studies.[21] One potential explanation for this relationship is that psychological stress seems to influence the wound-repair process.[22] More specifically, a meta-analysis showed a strong negative relationship between psychological distress and wound healing.[23] High stress levels are, for example, associated with physiological stress responses.[24] These stress responses can, in turn, retard the inflammatory phase and increase the risk of infection.[22] Another potential explanation for the relationship is that low levels of negative affective responses, such as anxiety and fear, will increase the likelihood of an athlete's having confidence in the formerly injured body part.[25] An athlete with confidence in his/her body is probably more likely to return to sports at an earlier stage than an athlete who is not confident in that the body will cope with the physical load related to participation in the sport activity.

Only two of the studies included in the meta-analysis focused on the relationship between rehabilitation adherence and RTP. The magnitude of this effect should therefore be interpreted with caution. Nevertheless, a strong positive effect of rehabilitation adherence on RTP was found. Compliance with a rehabilitation program, recommended by a physiotherapist, is one important aspect related to an increased chance of RTP.[26] Adhering to the recommended training program will increase the chance of the injured body part to recover and heal, which in turn will increase the chance of a successful comeback.

The path analysis showed that negative affective responses and rehabilitation adherence explained 36.0% of the variance in RTP. This result underlines the importance of considering psychological and behavioral factors in the injury rehabilitation process. There was a marginal, and not statistically significant, indirect effect of negative affective responses on RTP via rehabilitation adherence. This result contradicts the suggestion that behaviors will mediate the effect of negative affective responses on recovery as proposed in the dynamic biopsychosocial cycles of post sport injury response and recovery framework.[9] That psychological factors (e.g., emotions) have a causal, but often indirect, influence on behaviors has been shown in numerous studies in psychology.[27] The lack of a direct effect between negative affective responses and rehabilitation adherence (negative affective responses explained 1.2% of the variance in rehabilitation adherence) suggests that other variables might influence this relationship. Although a weak relationship (i.e., small effect size) was found between negative affective responses and rehabilitation adherence, associations might still exist between affective responses and other adaptive behaviors (e.g., help seeking, coping). Research on potentially adaptive behaviors other than rehabilitation adherence is warranted in future research.

Limitations and methodological considerations

This study has several limitations and methodological considerations that we want to address. First, the meta-analysis contains a small number of effect sizes. In particular, the estimate for the relationship between rehabilitation adherence and RTP as well as between negative affective responses and RTP (*k*s = 2 and 3) should be interpreted with caution because it is associated with low power.[28] Nevertheless, research has highlighted that the meta-analyses of a few studies may still provide important information.[29] Second, because few effect sizes were included in the analyses, no moderation analysis was possible to perform. Third, our decision to have RTP as our only rehabilitation outcome might have excluded studies that measured other relevant outcomes (e.g., knee function, pain). The reason for this decision was that we wanted to have an objective outcome that is meaningful for all members in the sporting community. Fourth, because we were interested in investigating both the direct and indirect paths among

negative affective responses, rehabilitation adherence, and the dependent variable of RTP, we used a saturated model. The limitation of a saturated model is that it is impossible to evaluate model fit because this type of model always has perfect fit to data. A saturated model can be used if a researcher is "interested in estimating certain model parameters, with associated measures of instability."[30]

Conclusion and practical recommendations

The results showed that both negative affective responses and rehabilitation adherence are related to a successful RTP after a sport injury. More specifically, both low levels of negative affective responses and high compliance with a rehabilitation plan were predictors of a successful RTP. Athletes should, therefore, work with stress management techniques to decrease the level of negative affective responses during the rehabilitation process, which in previous research has been related to successful rehabilitation outcomes.[31,32] Learning to take responsibility and to view an injury as a challenge instead of as a threat (problem-focused coping) has been one successful strategy. For practitioners, it is important to design an environment that decreases negative affective responses and maximizes rehabilitation adherence. A high-quality social support system and autonomous motivation have been suggested as important factors for enhancing rehabilitation adherence and decreasing negative affective responses.[33,34] We therefore suggest that information about how to create a supportive environment should be included in education modules for coaches, physiotherapists, and other practitioners working with injured athletes.

Disclosure

The authors report no conflicts of interest in this work.

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