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Diagnosis of psychosocial risk factors in prevention of low back pain in athletes (MiSpEx)

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ABSTRACT

Background Low back pain (LBP) is a common pain syndrome in athletes, responsible for 28% of missed training days/year. Psychosocial factors contribute to chronic pain development. This study aims to investigate the transferability of psychosocial screening tools developed in the general population to athletes and to define athlete-specific thresholds.

Methods Data from a prospective multicentre study on LBP were collected at baseline and 1-year follow-up (n=52 athletes, n=289 recreational athletes and n=246 non-athletes). Pain was assessed using the Chronic Pain Grade questionnaire. The psychosocial Risk Stratification Index (RSI) was used to obtain prognostic information regarding the risk of chronic LBP (CLBP). Individual psychosocial risk profile was gained with the Risk Prevention Index – Social (RPI-S). Differences between groups were calculated using general linear models and planned contrasts. Discrimination thresholds for athletes were defined with receiver operating characteristics (ROC) curves.

Results Athletes and recreational athletes showed significantly lower psychosocial risk profiles and prognostic risk for CLBP than non-athletes. ROC curves suggested discrimination thresholds for athletes were different compared with non-athletes. Both screenings demonstrated very good sensitivity (RSI=100%; RPI-S: 75%–100%) and specificity (RSI: 76%–93%; RPI-S: 71%–93%). RSI revealed two risk classes for pain intensity (area under the curve (AUC) 0.92(95% CI 0.85 to 1.0)) and pain disability (AUC 0.88(95% CI 0.71 to 1.0)).

Conclusions Both screening tools can be used for athletes. Athlete-specific thresholds will improve physicians' decision making and allow stratified treatment and prevention.

What are the findings?

Two new screening tools for psychosocial risk factors leading to back pain were successfully applied to athletes. The tools help to quantify the risk that an athlete will develop chronic back pain and to provide a personalised recommendation for intervention management.

How might it impact on clinical practice in the future?

The Risk Stratification Index is the first screening tool allowing precise estimation of athletes' psychosocial risk factors for chronic lower back pain and their potential pain experience within 1 year. High risk values suggest a detailed evaluation of athletes' psychosocial risk profile by using the Risk Prevention Index—Social screening tool. This identifies potentially effective psychosocial treatments in addition to medical, manual or exercise treatment and allows physicians to prescribe therapies targeted at the athlete's individual needs, resulting in quicker rehabilitation after LBP episodes.

INTRODUCTION

With a prevalence of 18%, chronic low back pain (cLBP) is one of the most common pain syndromes in the general population in Europe.[1 2] The lifetime prevalence of non-specific low back pain (LBP) is between 51% and 84%.[3 4] The majority of patients report pain relief within 1 year, but 24%–80% experience pain recurrence and 8% develop chronic pain.[1 2] cLBP is especially detrimental for athletes, limiting their performance and putting them at risk of early retirement from sport. Up to 28% of training days may be missed per year due to LBP, with a 12-month prevalance of 39% and a lifetime prevalence of 60%,[5] depending on the sports.[6] Since there is often no explicit pathology found in the development of chronic non-specific pain, current guidelines credit a multifactorial aetiology, which includes the significant influence of psychosocial risk factors.[7 8]

These so-called 'flag factors' are related to cognitive beliefs (eg, fear of pain, avoidance strategies and endurance), emotional states (eg, anxiety and depression) and distress and social context (eg, social support and healthcare context). The flag factors are colour coded—red, yellow, blue, black and orange flags—depending on the strength of their influence on developing chronic LBP,[9–12] whereby the yellow flags are the most well known. Although it is known that flag factors influence the development of chronic LBP,

they are still underused in clinics.[13 14] Methodologically simple screening instruments to support prevention and diagnosis are still scarce.

Until now, screening instruments designed for primary care settings have either classified patients with LBP into risk groups (eg, Heidelberg Short Early Risk Assessment Questionnaire for the Prediction of Chronicity in Low Back Pain, HKF-R[15] and the classification system for case complexity—INTERMED[16]) or have aimed to predict future LBP chronification risk based on the presence of yellow flags (eg, Risk Screening of Back Pain, RISC-BP,[17] Prognostic Model, PICKUP[18 19] and Örebro Musculoskeletal Pain Screenings Questionnaire (ÖMPSQ)).[20] Only one tool allows both a prognosis of pain chronification risk and a stratified allocation to risk and treatment groups (STarT Back DEscision Tool, SBDT).[21] However, all of these instruments share one problem when it comes to working with athletes: they were validated within patient populations[22] and therefore not applicable when recommending secondary preventions or exercise treatment settings that is essential for athletes' affairs.

To date, there is no LBP flag factor screening specifically validated for athletes. Athletes have different lifestyles and healthcare needs compared with the general population.[23 24] The effects of an athlete's daily training routine and the influence of athletic training on pain perception and processing[25–27] should be taken into account when estimating psychosocial risk factors for chronic pain and developing individualised treatment and prevention strategies. Two recently published screening tools, the Risk Stratification Index (RSI) and the Risk Prevention Index—Social (RPI-S)[28] seem promising for use with athletes. While the psychosocial RSI supplies a 1-year prognosis of chronic pain risk, the psychosocial RPI identifies individual risk profiles and a stratified treatment allocation. Both tools were developed with respect to exercise treatment effect modifiers and integrate athlete's relevant environmental factors, such as lifestyle and healthcare needs.

The objectives of this study were therefore (1) to evaluate the transferability of the RSI and RPI-S to athlete populations, (2) to determine if regular athletes demonstrated different risk index and profiles in comparison with recreational and non-athletes and (3), if necessary, to define optimal classification thresholds for regular athletes.

METHODS

Subjects

Athletes and non-athletes between the ages of 18 and 65 years were recruited for study participation and included if they fulfilled the following criteria: at least one episode (≥4 days) of non-specific LBP in the last 12 months and able to understand and to answer a questionnaire without help. Exclusion criteria were: acute back pain within the last 7 days, pregnancy, inability to stand and inability to fill in a questionnaire independently. All subjects were informed verbally and in writing about the contents of the study. All gave their written informed consent.

Instruments

Chronic Pain Grade questionnaire (CPG)

Pain was assessed using the CPG,[29] which indicates characteristic pain intensity (CPI: 0='no pain' to 100='strongest imaginable pain') and subjective pain disability (DISS: 0='no disability' to 100='inability to do anything') within the last 3 months.

Risk Stratification Index

The 1-year prognosis of the individual risk for developing chronic pain was assessed by the psychosocial RSI. This index (total of 21 items) is analysed in an 8-item scale for the prediction of future pain disability and in a 17-item scale for future pain intensity based on CPG values.[28] Greater RSI scores assume that psychosocial risk factors facilitate chronic pain development after LBP episode or injury and would recommend a deeper look into the risk profiles of the affected persons.

Risk Prevention Index—Social

A risk profile was obtained by the RPI-S. This index captures the individual psychosocial risk profile in four flag domains (RPI-S_P: pain experience: 15 items; RPI-S_S: distress: 16 items; RPI-S_{SE}: social environment: 20 items; RPI-S_{ME}: medical environment: 8 items). Identifying individual needs for stratified care allocation, the RPI-S supports the clinical decision making while offering an estimation about the treatment response sensitivity. This enables healthcare providers and physicians for a selection of optimal therapy components.

Study procedures

Data were obtained at baseline and at 1-year follow-up of a 2-year prospective multicentre study on cLBP (MiSpEx Network, design see ref 28). Five clinics participated in the study, which consisted of seven measurement points in the 24-month period (M1=baseline, M2=1 month, M3=3 months, M4=6 months, M5=12 months, M6=18 months and M7=24 months). Psychosocial data were collected using a web-based questionnaire. Furthermore, anthropometric data, pre-existing acute and chronic spine problems, treatments to date, medical record and physical condition were all assessed and noted by physicians.

Statistical analysis

Data processing of the questionnaires was based on the CPG manual; RSI and RPI-S- scales were summed up descriptively using the given regression weightings[28] (IBM SPSS V.24.0). Between-group differences were analysed using general linear models (GLM) with planned contrasts ($P<0.05$). All analyses were controlled for age. Finally, optimal discrimination thresholds for risk subgroups were calculated by receiver operating characteristics (ROC) curves. Cut-offs were established with the Youden's Index.[30] The range definitions of 'acceptable'

Table 1 Descriptive statistics (*M*, *SD*) and group differences calculated using GLM with age as a covariate

	G1: non-athletes <3 hours PA /week			G2: recreational athletes 3–10 hours PA /week			G3: regular athletes >10 hours PA /week			Analysis of group differences		
	n	M	SD	n	M	SD	n	M	SD	df	F	
Subjective disability (DISS)												
RSI-S	223	13.6	11.7	266	8.5	9.2	48	8.3	10.4	3, 533	29.76**	G1 > (G2, G3)
RPI-SP	237	13.1	8.6	279	8.8	6.4	51	7.4	6.4	3, 563	45.54**	G1 > (G2, G3)
RPI-SS	198	11.2	8.1	222	8.1	6.9	39	9.1	8.0	3, 455	28.35**	G2<G3
RPI-SSE	174	12.4	10.3	214	9.7	7.9	36	10.3	9.2	3, 420	18.10**	G2<G3
RPI-SME	209	12.2	8.6	230	9.1	7.1	39	8.9	8.3	3, 474	29.43**	n.s.
Characteristic pain intensity (CPI)												
RSI-S	232	25.4	13.0	274	18.8	11.9	50	18.1	14.3	3, 552	20.30**	G1 > (G2, G3)
RPI-SP	226	26.2	11.8	267	20.2	10.8	48	18.1	11.9	3, 537	24.45**	G1 > (G2, G3)
RPI-SS	240	24.8	11.6	280	19.4	10.6	51	17.9	12.5	3, 567	21.79**	G1 > (G2, G3)
RPI-SSE	209	25.9	11.9	261	19.8	11.0	48	17.6	11.4	3, 528	20.97**	G1 > (G2, G3)
RPI-SME	245	24.7	10.8	287	19.5	10.0	52	18. 3	10.6	3, 580	23.25**	G1 > (G2, G3)

Group differences calculated with planned contrasts. n_{total}=588 (9% regular athletes, 49% recreational athletes and 42% non-athletes).
GLMs, analyses of contrasts, statistically significant contrasts are reported.
*P<0.05; **P<0.01.
GLM, general linear model; PA, physical activity/exercise training; RSI, Risk Stratification Index; RPI, Risk Prevention Index—Social; RPI-S_{ME}, medical environment; RPI-S_P, pain experience; RPI-S_S, distress; RPI-S_{SE}, social environment.

Table 2 Subgroups and CPG scale points (0–100) for regular athletes

Risk subgroups	CPG points (scale range 0–100)	CPI n=51	DISS n=51
1. Low risk	0–29	39	46
2. Medium risk	30–49	8	4
3. High risk	50–69	3	0
4. Very high risk	70–100	1	1

CPG, Chronic Pain Grade questionnaire; CPI, characteristic pain intensity; DISS, subjective pain disability

(0.7–0.8), 'very good' (0.8–0.9) and 'outstanding' (>0.9) were used to interpret discriminant validity.[31]

RESULTS

Sample

At baseline, n=1071 participants were enrolled and completed the initial questionnaire. Of those, n=677 (65%) completed questionnaires at 1-year follow-up. Complete data sets for the presented calculation were available for n=588 (age: *M*=39 years, *SD*=13 years, *f*=57.5%). Drop-outs were mostly due to upcoming pregnancy, illness or relocation. Differences between participants who completed and those who did not were not observed. Participants were categorised depending on physical activity (PA), resulting in three groups: n=52: regular athletes (PA: >10 hours training/week; age: *M*=29 years, *SD*=10 years), n=289: recreational athletes (PA: 3–10 hours training/week; age: *M*=38 years, *SD*=13 years) and n=246: non-athletes (PA: <3 hours training/week; age: *M*=42 years, *SD*=13 years).

Descriptives and differences

Statistically significant group differences were observed for age ($F(2, 584)=23.74$, P<0.01), but not for gender.

RSI: regular athletes and recreational athletes revealed a significantly lower psychosocial risk index of developing chronic pain after 1 year compared with non-athletes (P<0.01). This applied to both GLM calculations, CPI ($F(3, 552)=20.30$, P<0.01) and pain disability (DISS) ($F(3, 552)=29.76$, P<0.01).

RPI-S: These findings remained consistent for the CPI risk profiles across the four risk domains (pain experience: RPI-S_P, distress: RPI-S_S, social environment: RPI-S_{SE}, medical environment: RPI-S_{ME}; P<0.01; see table 1). For DISS, regular athletes and recreational athletes showed significantly lower risk values than non-athletes in the domain pain experience (RPI-S_P: P<0.01). Solely in the profile domains, distress and social environment showed regular athletes with significantly higher risk values than recreational athletes (RPI-S_S: P=0.019; RPI-S_{SE}: P=0.012).

Discriminant validity

RSI: The cut-off for the pain intensity index of the highest risk group was 32 points (subgroup 3: risk for CPI of >50 after 1 year, table 2) with 100% sensitivity and 93% specificity. A negative likelihood ratio (LR) of 0.00 and a positive likelihood ratio of 14.99 suggest substantial support in clinical decision making. For pain disability, only one cut-off was calculable with 80% sensitivity and 93% specificity (LR– 0.22 up to LR+ 11.43).

Table 3 Sensitivity, specificity, negative and positive likelihood ratios (LR) for RSI and RPI-S generated with Youden's Index

A) Subgroups Cut-off values	Sensitivity %	Specificity %	Negative LR	Positive LR
RSI ≥22	100	76	0.00	4.22
RSI ≥32	100	93	0.00	14.99
RPI-SSE ≥21	75	71	0.35	2.63
RPI-SSE ≥32	75	91	0.28	8.06
RPI-SS ≥19	83	74	0.23	3.17
RPI-SS ≥28	100	89	0.00	9.09
RPI-SP ≥21	91	86	0.11	6.54
RPI-SP ≥29	100	93	0.00	14.29
RPI-SMC ≥22	83	82	0.20	4.64
RPI-SMC ≥24	100	77	0.00	4.27
B) Subgroups Cut-off values	**Sensitivity %**	**Specificity %**	**Negative LR**	**Positive LR**
RSI ≥19	80	93	0.22	11.43
RPI-SSE ≥8	80	73	0.27	2.96
RPI-SS ≥9	100	67	0.00	3.03
RPI-SP ≥6	100	50	0.00	2.00
RPI-SMC ≥9	80	70	0.29	2.67

Negative/positive likelihood ratio of 0.2–0.5/2–5=small difference, relevant for clinical decision making;
0.1–0.2/5–10=moderate difference, substantial for clinical decision making; <0.1/>10=clinical important difference, highest test quality. Due to small sample sizes, cut-offs for only one group was calculated.
Calculations based on CPG Scale Characteristic Pain Intensity (CPI), n=51.
CPG, Chronic Pain Grade questionnaire; RSI—Risk Stratification Index; RPI, Risk Prevention Index—Social; RPI-S_P, pain experience; RPI-S_S, distress; RPI-S_{SE}, social environment; RPI-S_{MC},medical environment

RPI-S: The sensitivities of risk profiles and stratified treatment allocation were between 75% and 100% and specificity between 71% and 93%. The negative likelihood ratios ranged from 0.00 to 0.35 for pain intensity and from 0.00 to 0.29 for pain disability, indicating small differences. Positive LRs for pain intensity ranged from 2.63 to 14.99, and for pain disability from 2.00 to 11.43, indicating moderate differences and substantial aid for clinical decision making (see table 3A,B). Disability calculations of sensitivity and specificity were only possible for subgroup 1 (lowest risk) due to low sample sizes in the higher risk groups.

The discriminant validity for the 1 year prognosis of the RSI differentiated two risk classes and performed very well (pain intensity: area under the curve (AUC) 0.92 (95% CI 0.85 to 1.0) and pain disability: AUC 0.88

Table 4 Discriminant validity: AUC for risk subgroups based on CPG scales characteristic pain intensity (CPI) and subjective pain disability (DISS)

	Risk subgroups	AUC (95% CI)	
		CPI	DISS
RSI	1 vs 2/3/4	0.92 (0.85 to 1.0)	0.88 (0.71 to 1.0)
	1/2 vs 3/4	0.97 (0.93 to 1.0)	0.48 (0.33 to 0.62)
	1/2/3 vs 4	–	–
RPI-SSE	1 vs 2/3/4	0.82 (0.70 to 0.95)	0.71 (0.50 to 0.91)
	1/2 vs 3/4	0.90 (0.71 to 1.0)	0.44 (0.27 to 0.61)
	1/2/3 vs 4	–	–
RPI-SS	1 vs 2/3/4	0.90 (0.80 to 0.99)	0.85 (0.70 to 1.0)
	1/2 vs 3/4	0.97 (0.92 to 1.00)	0.65 (0.49 to 0.80)
	1/2/3 vs 4	–	–
RPI-SP	1 vs 2/3/4	0.93 (0.85 to 1.0)	0.77 (0.56 to 0.99)
	1/2 vs 3/4	0.98 (0.94 to 1.0)	0.36 (0.19 to 0.46)
	1/2/3 vs 4	–	–
RPI-SMC	1 vs 2/3/4	0.87 (0.76 to 0.98)	0.69 (0.45 to 0.94)
	1/2 vs 3/4	0.91 (0.80 to 1.0)	0.20 (0.07 to 0.33)
	1/2/3 vs 4	–	–

RSI, Risk Stratification Index as well as RPI, Risk Prevention Index—Social; RPI-S_P, pain experience; RPI-S_S, distress; RPI-S_{SE}, social environment; RPI-S_{MC},medical environment.

(95% CI 0.71 to 1.0)). The discriminant validity for the risk profile (RPI-S) in the first subgroup revealed AUCs ranging between 0.82 and 0.93 for pain intensity and between 0.69 and 0.85 for pain disability (see table 4).

DISCUSSION

We evaluated the transferability of the psychosocial RSI and RPI-S to athletes, to investigate differences in prognostic risk index and risk profiles between regular and recreational athletes as well as non-athletes, and then, if necessary, to define optimal classification thresholds for regular athletes.

Transferability

Both screening instruments (RSI and RPI-S) can accurately and reliably be transferred to regular athletes. The psychosocial RSI provides a precise estimation of the expected individual CPG pain intensity and disability value for a regular athlete up to 1 year later. With eight questions and clear discrimination thresholds,[31] the RSI offers physicians an insight into the chronic pain disability risk of their athletes. The discrimination validity outperforms standardised instruments in the general population (eg, PICKUP,[18 19] STarT-Back[21] and ÖMPSQ.[20] The psychosocial RPI also provides physicians with insight into the psychosocial risk profile of their athletes and allows them to personalise treatment decisions with strong likelihood ratios that suggest a substantial improvement in clinical decision making, as requested in modern concepts of secondary prevention.[9 32]

Group differences

Regarding differences between groups, regular athletes and recreational athletes both displayed lower psychosocial prognostic risk indices of developing chronic LBP, and furthermore, lower psychosocial risk profiles compared with non-athletes. These results extend epidemiological data showing lower LBP lifetime prevalence in athletes[5] than in the general population.[3 4] Possible explanations are benefits due to a physically active lifestyle, social integration in sport clubs and training adaptation effects in skeletal muscles. Also, athletes receive different healthcare management than does the general population, with more frequent and regular check-ups.[23 24] Athletes may, in addition, continue engaging in PA despite acute pain.[33]

Another point, recently discussed in a meta-analysis,[25] is that regular athletes may have a greater pain tolerance compared with the general population. However, available data on pain thresholds are less convincing. Further explanations touted are that somatosensory processing in regular athletes differs due to a less responsive endogenous pain inhibitory system[26] or that exercise reduces pain due to an exercise-induced hypoalgesia (EIH).[27 34] However, greater stress exposure (eg, stress analgesia) leads to maladaptations of this EIH and to pain sensitisation[35] as it has been observed in former soldiers.[36] Although, the complete aetiology has yet to be clarified, our data confirm the higher stress risk profiles for pain disability in regular athletes but lower overall risk values. This was also expected with regards to pain intensity, but no such evidence was found. It is evident that increasing training volumes, travel times and media tasks within an international competition schedule boost the distress and social environment profiles of regular athletes in comparison with recreational athletes.[37 38] This complex U-shaped interaction between biology, psychology and exercise[35] may explain the paradoxical propensity of regular athletes to develop chronic pain,[26] despite continuous exercise also being an important protective factor in developing chronic LBP.

Limitations

Limiting factors of the study, which must be considered, are: (1) the small sample sizes and the imprecise nature of lower back pain prevalence calculations among athletes, in which for our purposes were estimated based on the total sample. The prevalence in athletes of CPG-CPI ≥50 was 7% within the entire sample, which indeed corresponds with prevalence literature of persistent, non-specific lower back pain in the general population.[1 2] (2) The small number of athletes with chronic back pain in a higher CPG grades (especially related to DISS), which further limited the analysis and results and should be replicated in other samples. (3)

The length of the screening instrument seemed appropriate, but the full RPI-S (for all risk profiles) can reach up to 50 questions.

SUMMARY

The RSI is the first screening tool allowing an exact estimation of athletes' psychosocial risk of developing chronic LBP and their potential pain experience within 1 year. The RPI-S describes athletes' psychosocial risk profiles in four flag domains and the specific needs of additional psychosocial treatment in addition to the usual medical, manual or exercise treatment. This auspicious opportunity may support a specified type and dosage of training therapy resulting in quicker rehabilitation after LBP episodes for regular athletes. This essential question is currently being further analysed in two randomised controlled exercise treatment studies of the MiSpEx Network.[39 40]

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Competing interests None declared.

Patient consent Obtained.

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