Human Movement Science 57 (2018) 178–183

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

Full Length Article

Knee misalignment and exercise amount: Predictive value for chronic low back pain in young competitive athletes

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ARTICLE INFO

Keywords:
Sports medical examination
Chronic low back pain
Leg axis deviation

ABSTRACT

Sports medical examinations of juvenile athletes provide an opportunity for preventive measures against sports-related diseases. Determining the leg axis deviation as a risk factor for future constraints may offer approaches for such measures.

Data were obtained from 789 youth athletes: 166 with coronal plane knee misalignment and 623 without. After a seven-year period, 64 participants (m: 33, f: 31) from both groups were reassessed for the incidence of nonspecific chronic low back pain (CLBP). To distinguish participants with increased risk for CLBP, contingency tables for comparison of expected and joint frequency distribution testing and receivers operating characteristic (ROC) analyses for the weekly training time were conducted.

Subjects with an initial diagnosed knee misalignment showed increased risk for the development of CLBP ($CHI^2 = 4.2$, $p < .05$, OR = 3.4) compared to participants without knee misalignment. In athletes with knee misalignment, ROC analysis revealed an optimal cut-off of 6.75 h/w (AUC = 0.8; $Chi^2 = 4.2$, $p < .05$, OR = 8.0). In athletes without leg axis deviation, no association to training volume was detected.

Our results suggest a predictive value of knee misalignment on the later occurrence of CLBP in young competitive athletes and underline the importance of an examination of the motor system during sports medical assessments in youth athletes. Training volume of almost more than 7 h a week enhances this risk.

1. Introduction

The preparticipation evaluation (PPE) is recommended by international sports medicine societies for everyone engaging in leisure time sports or systematic exercise training (Pescatello, 2014). It is mandatory in some countries for youth competitive athletes, participating in national teams or federal leagues (Wingfield, Matheson, & Meeuwisse, 2004).

Recommendations for the PPE are inspired by general healthcare practice and largely lack of sports specific evidence (Conley et al., 2014; Headlee, Nord, & Huntington, 2014). The recommended diagnostic procedures range from a comprehensive medical examination including echocardiography (ECG) by default in Italy, to a questionnaire-based preselection to identify athletes needing full work-up due to existing medical conditions in the United States (Bar-Cohen & Silka, 2012; Galas, 2014; Wingfield et al., 2004).

Even if medical conditions of the motor system and, in particular, of the lower extremities (e.g. knee misalignment, foot deformities) play an important role in young athletes (Brudermanns, 2012; Mayer et al., 2012; Rosenhagen, Pommerening, Vogt, &

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https://doi.org/10.1016/j.humov.2017.12.004
Received 24 May 2017; Received in revised form 28 November 2017; Accepted 7 December 2017
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Banzer, 2009), their prognostic potential to determine upcoming disabilities or illnesses has not been evaluated yet. Because of the important role in stabilizing the trunk during movements of upper and lower extremities, the spine and core muscles are anticipatory involved in almost all human movements (Haus & Micheli, 2012; Young & d'Hemecourt, 2011). Misalignment of the lower extremities, particularly in athletes, increases biomechanical stress and may facilitate pelvic instability as well as low back pain (Harris-Hayes, Sahrmann, Dillen, & Linda, 2009; Nadler, Wu, Galski, & Feinberg, 1998).

In a recently published study, Schmidt et al. (2014) found an increased low back pain prevalence in competitive youth athletes compared to non-athletes and discuss the participation in competitive sports as an important etiologic factor. This association is supported by the data of Launay (2015), stating that competitive sports, led to more frequent (training) overload of the musculoskeletal system of adolescents in the last decades. Reasons for that can be seen in repetitive flexion, hyperextension and axial loading in the course of heavy lifting, frequent bending and rotating as well as anatomically unfavorable postures and whole body accelerations (McKenzie & May, 2003).

Since the proposed association of knee misalignment, training amount and the occurrence of low back pain has not yet been investigated, our study was designed to delineate this potential association and thereby advance our understanding of the motor system and its changes as a function of repetitive training loads over time. Overall, we hypothesize knee misalignment and its mechanical effect and higher training time in the sense of shorter regeneration interval may have predictive values for the later development of chronic nonspecific low back pain.

2. Methods

2.1. Design and ethical standards

The study was approved by the local ethical review committee for research and conducted in accordance to the ethical standards set by the declaration of Helsinki with its recent modification of Fortalezza (Brazil, October 2013) and meets the ethical standards in sport and exercise science according to Harriss and Atkinson (2015). It was carried out as a prospective observational study.

2.2. Participants

Healthy subjects (n = 789) aged between 12 and 18 years were consecutively recruited at the annual sports medical examination in Hesse (Germany) from Nov 2006 to Oct 2007. This standardized yearly routine check-up is mandatory for youth competitive athletes participating in federal state teams and follows the guidelines of the German Society for Sports Medicine and Prevention (Deutsche Gesellschaft für Sportmedizin und Prävention, DGSP). Participants of these teams engage in all training aspects of the relevant sport with a weekly load of 4–15 h depending on the sport. Each participant and their parents or legal guardian signed informed consent before study enrolment. Subjects were considered eligible if they (1) were member of the youth competitive sports team of the federal association of any sport, (2) received medical approval for participation in professional training and (3) have no previous back impairments.

2.3. Data acquisition and processing

Besides the full medical check-up, data acquisition for study purpose included personal information (examination day, date of birth, gender, contact information for follow-up) and anthropometric values (height and weight). Actual sport and exercise engagement was recorded according to the FITT-principle (frequency, intensity, time, type) including all sports and match participation.

To satisfy validity criteria, the same experienced orthopedic specialist examined leg axis throughout the entire survey period. Participants were investigated unclothed and in a comfortable neutral standing position. Clinical knee alignment rating was conducted in the frontal plane by systematically determining the intercondylar/intermalleolar distance (Ingham et al., 2010). Sufficient quality criteria for validity with a sensitivity of 75% and a specificity of 100% as well as for observer reproducibility with $\kappa = 0.89$ was recently shown for this procedure (Ingham et al., 2010).

Subjects with knee misalignment, irrespective of genu valgum or varum, were 2:1-matched with controls, using age, gender and sport as criteria. Two control participants without leg axis deviation but appropriate matching criteria were thus assigned to one athlete with misalignment. In case of more than two existing controls, the closest matching age (months) was elected.

Seven years after baseline examination, 64 participants from stratified groups were investigator-blinded re-evaluated to assess the incidence of chronic nonspecific low back pain (CLBP, dichotomized). Inclusion criteria for the CLBP group were: pain persistence of > 13 weeks including (at least one) painful episode(s) in the past two weeks and for at least half of the time of the previous 12 months, in single or multiple episodes. Asymptomatic subjects were accordingly assigned to the group without CLBP. In both groups, subjects with nerve root tension, neurological deficits, previous surgery of the spine, any persistent or passed lower spine complaints based on space-occupying, inflammatory, traumatic or systemic processes, radicular and/or pseudoradicular symptoms, inflammatory rheumatic diseases, osteoporosis or spondylolysis, as well as severe cardiovascular, pulmonary, neurological, cancerous, endocrine and psychiatric diseases, fibromyalgia or hemophilia were excluded.

Data from each subject with complete dataset (initial and reevaluation) and from patients without applicable exclusion criteria were included into further analysis.

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