山西省教学成果奖（高等教育）申报材料

成 果 名 称　山西医科大学运动康复专业“一基两翼”课程体系对人才培养的探索研究

成果完成人 杜旭峰 赵良渊 殷　凤 杨　英

成果完成单位　山　西　医　科　大　学

成 果 科 类　教育学

类 别 代 码　0 4 1 1

推 荐 序 号　0 5 1 5

成 果 网 址

推荐单位名称　山西医科大学

推 荐 时 间　2021 年 5 月 20 日

山西省教育厅

目　　录

山西省教学成果奖（高等教育）申报书

成 果 名 称　山西医科大学运动康复专业“一基两翼”课程体系对人才培养的探索研究

成果完成人 杜旭峰 赵良渊 殷 凤 杨 英

成果完成单位 山 西 医 科 大 学

成 果 科 类　教育学

类 别 代 码　0 4 1 1

推 荐 序 号　0 5 1 5

成 果 网 址

推荐单位名称　山西医科大学

推 荐 时 间　2021 年 5 月 20 日

山西省教育厅

填 表 说 明

1．成果名称：字数（含符号）不超过35个汉字。

2. 成果科类按照教育部颁布的《普通高等学校本科专业目录（2012年）》（教高[2012]9号）的学科门类分类（规范）填写。综合类成果填其他。

3．成果类别代码组成形式为：abcd，其中：

ab：成果所属科类代码：填写科类代码一般应按成果所属学科代码填写。哲学—01，经济学—02，法学—03，教育学—04，文学—05，历史学—06，理学—07，工学—08，农学—09，医学—10，军事学—11，管理学—12，艺术学－13，其他—14。

c：成果属普通教育填1，继续教育填2，其他填0。

d：成果属本科教育填1，研究生教育填2，其他填0。

4．推荐序号由4位数字组成，前两位为推荐单位代码，按照附件1《2017年山西省教学成果奖（高等教育）推荐名额分配表》中各推荐单位代码填写，后二位为推荐单位推荐成果的顺序编号。

5．成果曾获奖励情况不包括商业性的奖励。

6．成果起止时间：起始时间指立项研究或开始研制的日期;完成时间指成果开始实施(包括试行)的日期。

7．本申请书统一用A4纸双面打印，正文内容所用字型应不小于4号字。需签字、盖章处打印或复印无效。

一、 成 果 简 介（可另加附页）

	获 奖 时 间	奖项名称	获 奖 等 级	授 奖 部 门
成果曾获奖励情况	2020.11	山西医科大学运动康复专业“一基两翼”课程体系	三等奖	中国康复医学会
	2020.11	运动康复专业为省级一流专业	省级	山西省教育厅
	2019.12	第 22 届 CUBA 中国大学生篮球联赛（山西赛区）暨 2019 年山西省大学生篮球锦标赛	授予山西医科大学运动康复系：突出贡献奖	山西省教育厅 山西省体育局
	2019.10	山西省校园足球赛	授予山西医科大学运动康复系：突出贡献奖	山西省教育厅 山西省体育局
成果起止时间	起始： 2013 年 7 月　　实践检验期：6 年 完成： 2015 年 7 月			

1.成果简介及主要解决的教学问题(不超过 1000 字)

成果简介：山西医科大学体育教学部（运动康复系）运动康复专业结合我校特有的医学资源、专业发展特点、培养目标、办学定位以及国家对运动康复专业人才的需求等，通过调查研究制定了涵盖基础医学通识类课程、体育类课程、康复类课程在内的的运动康复专业课程体系，我们将其命名为“一基两翼”的课程体系，于 2015 年 7 月开始使用，现已使用 6 年。所谓“一基两翼”即：“一基”为医学基础类课程（包含内科、外科、、诊断、影像、针灸、病理、解剖等专业医学课程）；“两翼”即体育类课程（田径、体操、篮球、足球、排球、运动训练学等运动类课程）和康复类课程（康复功能评定学、肌肉骨骼康复学、运动疗法技术学、物理治疗学等康复类课程），在医科类院校独有的资源下使学生更加全面的学习运动康复专业理论及实践知识。为加强专业建设，不断满足学生学习和就业的需要，我校运动康复专业课程体系进行了部分课程学时的修改，但是特有的“一基两翼”的课程体系框架没有发生变化。在使用之前，我校组织相关专家对课程设置进行专家论证，并在每年的使用过程中对任课教师、学生等进行满意度调查。北京体育大学矫伟教授、山西白求恩医院康复医学科主任梁英教授以及武俊英教授、美国伊斯卡大学关红卫教授等国内外专家对我校运动康复专业的课程体系进行过专业论证，通过论证专家们对我校特有的“一基两翼”的课程体系表示赞同，我校运动康复专业毕业及在校学生、任课教师对“一基两翼”的课程体系满意度高达 92.89%。

基础课程	体育类课程	康复类课程
运动解剖学	运动训练学	人体发育学
细胞生物学	田径	运动营养学
心理学	体操	医务监督
生物化学	篮球	康复功能评定学
运动生理学	排球	肌肉骨骼康复学
病理学	武术	运动急救
医学影像学	体育概论	贴扎术
药理学	足球	运动处方
运动生物力学	体育舞蹈	针灸学
诊断学	小球运动（乒乓球）	物理治疗学
内科学基础	小球运动（羽毛球）	运动损伤康复
外科学基础	健美操	运动疗法技术学
中医基础理论	专业英语	康复心理学
医学信息检索与利用	游泳运动	拉伸术
医学伦理学	跆拳道	中医养生康复
组织胚胎学	体育统计学	推拿与按摩
	拉伸术	运动康复器械组合训练
	核心功能训练	
	体育科学研究方法	

解决的教学问题：在健康中国和体医融合的大背景下，我校运动康复专业“一基两翼”课程体系的制定基本符合目前国家和社会对运动康复专业人才的需求，将运动与康复完美结合，借助我校得天独厚的医学优势，与学校各院系之间形成联动，使用一流的教学团队和专业的实验室，为培养又红又专的专业人才提供了有力保障，同时课程建设打破了部分院校只将康复课程作为专业核心课程的课程设置，使得运动康复专业有了体育范。

2.成果解决教学问题的方法(不超过 1000 字)

（1）我校作为医科类院校，医学教学资源是我们的优势，运动康复专业基础类课程基本由我校经验丰富的基础医学院、第一临床医学院、管理学院、公共卫生学院、医学影像学院等教学团队来承担，专业的教学团队和一流的实验室使得学生学习基础类知识的热情高涨。

（2）我校运动康复专业康复类课程主要由我校附属医院有很强临床经验的医师团队来承担，丰富的临床经验使教学课堂充满无限乐趣，理论与实践的完美结合为专业实习打好坚实的基础。

（3）运动康复专业的体育课程注重理论与实践的有机结合，一半学时的理论教学加一半学时的实践教学使学生在学习基本技战术的同时了解运动原理及常见损伤康复。

（4）“一基两翼”课程体系的构建完成后并非一成不变，根据国家对运动康复专业人才需求及运动康复专业前言动态、教学体系评价机制、教师和学生满意度调查等不断的增减课程，使“一基两翼”的课程体系

不断完善，满足教师的教和学生的学，为努力打造全国一流专业建设服务。

（5）教学实习基地在依托我校20余所附属医院的基础上，不断探索新的教学实习基地，我校于山西省体育局、太原市体育局签署战略合作框架协议，现有我校部分附属医院康复科、山西省体育局、各运动队、职业俱乐部等实习基地。目前我校运动康复专业学生的教学实习基地，涵盖了体育、医院等多领域的教学实习基地，按照《高等学校本科专业类教学质量国家标准》规定，我校的专业毕业实习时间调整为44周，为学生的专业理论所学提供了全面的实习空间，使学生将理论所学用于实际操作过程中，现已有三届学生完成专业实习，我校运动康复专业学生的专业能力受到实习单位的一致好评。

（6）我校一直致力于扩大运动康复专业学生的实习领域，在加强与省体育局战略合作协议深入开展的同时，继续促进与山西省男、女篮球俱乐部的合作，与司法厅戒毒所的合作，与部队在体适能训练方面的合作，与医院的合作、与康养中心的合作、与健身指导会所等等的合作，好的课程体系对培养学生质量方面起着关键性的作用，将更有利于实习基地的不断扩大。

3.成果的创新点(不超过800字)

目前全国开设运动康复专业的院校主要有医科类院校、体育类院校、师范类院校、综合类院校和独立院校等，因此各高校的人才培养呈现百花齐放、百家争鸣态势。针对如何培养社会所需要的应用型运动康复人才，学者们进行了大量分析研究，主要集中在人才培养模式、存在的问题、现状分析和教学改革等方面。作为人才培养的核心要素，课程的建设水平和质量直接决定人才培养质量。目前不同的院校在运动康复专业课程体系建设上存在一定的差异，体育类院校主要以运动人体科学作为基础，课程设置以体育理论知识和运动技能为主要课程；医学类院校主要以医学资源为背景，体育类课程相对较少，综合类院校也是在体育教学的基础上进行课程设置，不同院校的课程体系建设基础不同，课程体系建设存在一定的偏差。

作为医科类院校，通过调查分析研究，我校运动康复专业按照国家及社会需求，根据《高等学校本科专业类教学质量国家标准》规定及专业培养目标、办学定位等，结合我省、我校的专业需求及特点，大胆创新实践，制定了具有专业特色的“一基两翼”的课程体系，其课程设置将基础医学、体育、康复三部分内容同时融入到运动康复专业课程体系中，增加课程的实践教学及实习时间，整体课程高度融合。独特、全面的课程体系建设适当弥补了体育类院校医学康复类课程的缺失和医科类院校运动类课程的缺失等。

从运动康复专业的定义来说，运动康复专业是体育与医学交叉的新

专业，这就说明该专业与单纯的康复专业有着本质的区别，它是将体育与医学相关知识结合所产生的独立专业，因此区别于我校的康复治疗专业。我校运动康复专业的课程体系打破了以往以基础医学类课程和部分临床康复类课程为主要课程的课程体系建设，在健康中国和体医融合的大背景下，符合符合国家发展要求和一流专业的建设需求，为培养又红又专的专业人才提供有力保障。

4. 成果的推广应用效果(不超过 1000 字)

我校运动康复专业“一基两翼”课程体系从 2015 年开始使用，至今已经使用 6 年，专家、教师、学生的反映良好。2020 年 11 月申报的山西医科大学运动康复专业“一基两翼”的课程体系获得中国康复医学会教学成果三等奖。

我校运动康复专业以国家大力发展体医融合为契机，以我校得天独厚的医学资源为优势，充分发挥体育的作用，建立符合专业发展且具有医学院特色“医中有体、体中有医”的培养体系，“一基两翼”的课程体系体现了健康中国、体医融合的培养目标，2020 年 11 月成功申报成为省级一流专业，我们还将不断努力为早日成为国家级一流专业。运动康复不仅仅是病灶康复，更强调的是针对不同人群的预防、治疗、运动处方、机能和技能的康复。

我校运动康复专业学生就业率为 90%左右，学生毕业的去向主要有专业运动队、各级医院的康复机构、体育运动基地、健康休闲俱乐部、职业运动俱乐部、康养中心、社区、健康与康复科研所、体育与卫生行政部门等机构，专业从事康复治疗、健康教育、健康测定与评估、健身指导、卫生保健、医疗监督、科学研究及行政管理的工作。运动康复专业学生可以成为康复技师、运动防护师、体能训练师等等。目前，我校运动康复专业的实习基地涵盖了康复基地、运动队、医院等领域，还将不断拓展康养中心、社区、专业康复机构等，在不同的实习基地，学生们将理论与实践的有机结合，实践能力不断增强，受到各个实习基地的一致好评，学生就业前景一片光明，就业单位主要有康养中心、职业俱乐部、各种康复机构、医院康复科、自主创业使用所学自建康复中心等等。

2019 年 11 月我校运动康复学生成立的山医大康复工作室受山西省教育厅、山西省体育局委派承担 2019 年山西省校园足球赛、第二十二届 CUBA 基层赛的医务保障工作，圆满完成保障工作，受到各个代表队的一致好评，并授予我校运动康复专业突出贡献奖称号。

二、完成人情况

主 持 人 姓　　名	杜旭峰	性　　别	男
出生年月	1981 年 8 月	最后学历	研究生
专业技术 职　　称	讲师	现 任 党 政 职 务	体育教学部（运动康复系）副主任
现从事工 作及专长	体育教学部（运动康复系）副主任　足球训练、拉伸术、核心训练		
工作单位	山西医科大学		
联系电话	0351-3985077	移动电话	13835180055
电子信箱	32468433@qq.com		
通讯地址	山西省晋中市榆次区高校园区山西医科大学中都校区		
何时何地受何种省部级及以上奖励	第二届全国青年运动会组织筹办工作先进个人		
主 要 贡 献	作为院系分管教学工作副主任，全面把控运动康复专业课程体系建设全过程；同时是运动康复专业“一基两翼”课程体系的主要制定人、执行、监督人、修订者。一直以来，积极努力致力于运动康复专业建设中，多次外出参加各种康复类会议，赴兄弟院校、康复医院、实习基地等展开调研学习，了解运动康复专业领域前言动态、运动康复专业建设需求、专业学生就业方向、社会需求等等，在专业建设方面提出很多建设性的意见，为建设国家级一流专业不断努力。 本 人 签 名： 年　　月　　日		

完成人情况

第（1）完成人 姓　　名	赵良渊	性 别	男
出生年月	1971 年 4 月	最后学历	研究生
专业技术 职　　称	教授	现 任 党 政 职 务	武装保卫部 （处）处长
现从事工 作及专长	篮球训练及裁判、核心训练、运动处方、康复器械组合训练、统计学		
工作单位	山西医科大学		
联系电话	03513985077	移动电话	13834117926
电子信箱	414861955@qq.com		
通讯地址	山西省晋中市榆次区高校园区山西医科大学中都校区		
何时何地受何种省部级及以上奖励	2018 年山西省“三晋英才”拔尖骨干人才 第二届全国青年运动会组织筹办工作先进个人		
主 要 贡 献	**作为运动康复专业带头人，在专业建设、课程体系建设等方面把握整体的框架思路，在专业建设方面贡献卓越，在课程体系建设方面给出很多建设性的意见和建议，运动康复专业现为省级一流专业，继续努力建设国家级一流专业。** 本 人 签 名： 年　　月　　日		

完成人情况

第(2)完成人 姓　　名	殷凤	性 别	女
出生年月	1973 年 3 月	最后学历	研究生
专业技术 职　　称	讲师	现 任 党 政 职 务	运动康复系书记
现从事工 作及专长	运动康复系书记　　基础医学、运动训练、核医学		
工作单位	山西医科大学		
联系电话	03513985077	移动电话	13934606123
电子信箱			
通讯地址	山西省晋中市榆次区高校园区山西医科大学中都校区		
何时何地受何种 省部级及以上奖励	无		
主 要 贡 献	**作为运动康复系书记，从学生和教师满意度调查中对学生的使用情况进行过总结、反馈** 本 人 签 名： 年　　月　　日		

完成人情况

第(3)完成人 姓　　名	杨　英	性 别	女
出生年月	1984 年 10 月	最后学历	研究生
专业技术 职　　称	实验师	现 任 党 政 职 务	体育教学部（运动康复系）科教科副科
现从事工 作及专长	运动康复系科教工作　　排球理论与实践、体育统计		
工作单位	山西医科大学		
联系电话	03513985077	移动电话	13485351246
电子信箱	421455440@qq.com		
通讯地址	山西省晋中市榆次区高校园区山西医科大学中都校区		
何时何地受何种 省部级及以上奖励	无		
主 要 贡 献	**运动康复专业“一基两翼”课程体系的主要制定者，全面调整专业课程体系、组织相关调研、专家论证、修订等工作** 本 人 签 名： 年　　月　　日		

三、完成单位情况

主　　持 单位名称	山西医科大学	主管部门	山西省教育厅
联 系 人	杜旭峰	联系电话	13835180055
传　　真		邮政编码	030600
通讯地址	山西省晋中市榆次区高校园区山西医科大学中都校区		
电子信箱	32468433@qq.com		

主 要 贡 献	运动康复专业“一基两翼”课程体系的建设及规划 运动康复专业“一基两翼”课程体系的实施 运动康复专业“一基两翼”课程体系的修订及完善 运动康复专业建设保障 单 位 盖 章 年　　月　　日

四、推荐单位意见

推荐意见	（本栏由推荐单位填写，根据成果创新性特点、水平和应用情况写明推荐理由和结论性意见） 经山西医科大学教学成果奖评审委员会评审，同意推荐杜旭峰老师牵头的山西医科大学运动康复专业“一基两翼”课程体系对人才培养的探索研究申报山西省教学成果奖。 推荐单位公章 年　　月　　日

五、评审意见

评审组意见	山西省教学成果奖（高等教育）评审组组长 签字： 年　　月　　日
评审委员会意见	山西省教学成果奖（高等教育）评审委员会主任 签字： 年　　月　　日

教学改革项目

山西医科大学文件

山医大教〔2018〕7号

山西医科大学
关于2018年校级教育教学改革研究项目立项的
通　　知

各教学单位，行政各部门，各教辅单位、重点科研单位，各附属单位：

根据《山西医科大学教育教学改革项目管理办法》（山医大校教字[2015]19号）文件要求，经个人申报、院系初评、教务处初审、专家评审，2018年3月27日校长办公会议研究，决定确立2018年山西医科大学教育教学改革研究立项项目共163项。重点项目26项，其中12项获得省级教改立项项目的研究经费由省教育厅资助，其余14项由学校资助，每项资助金额0.5万元,共7万元；一般项目115项,每项资

附件

2018年山西医科大学教育教学改革创新项目立项名单

重点项目（首字母S开头的项目为省级资助项目）				
项目类别	项目编号	项目名称	承担单位	项目负责人
人才培养	SJ2018001	医患共享决策（SDM）文库的构建与临床医学生医患沟通能力培养模式探讨	第一临床医学院	王 彦 刘云峰 任 毅 张 瑾 腾 云 张 倩 李 彦
	XJ2018002	基于健康中国战略的医学生人文胜任力和临床胜任力培养路径探索与实践	第一临床医学院	刘 春 陈 爱 王斌全 王志中 韩清华 孙海飚 李娜娜
	XJ2018003	基于“互联网+”背景下地方院校机能学创新创业人才培养模式探索与实践	基础医学院	侯晓敏 张明升 张轩萍 章 毅 刘 宇 杨彩红 王 燕 梁月琴 郑建峰 秦小江
	XJ2018004	基于“双创型”人才培养的本科生CDIO实践教学模式研究	基础医学院	卞 伟 刁海鹏 吕俊杰 王茹林 王浩江 李 波 姚 杰 马素芳
	SJ2018005	新型法医学专业人才创新思维与临案分析能力培养的研究	法医学院	孙俊红 张蕾蕾 王英元 贠克明 高彩荣 梁新华 杜秋香 尉志文 贾 娟 曹 洁 张更谦 苏红亮 李泽琴 杨 蓉 郑瑞丽
	SJ2018006	大数据时代医学信息学专业学生创新创业能力培养研究与实践	管理学院	于 琦 贺培凤 卢学春 吕艳华 吴胜男
	XJ2018007	基于项目驱动的PBL教学与医学信息交叉学科创新人才培养新模式	管理学院	袁永旭 贺培凤 郭文秀 于 琦 时丽芳
	SJ2018008	山西省运动康复专业本科生培养模式的构建	体育教学部	赵良渊 王建功 胡 鑫 杜旭峰 王 东 闫旺旺
	XJ2018009	大数据驱动背景下医学创新人才培养模式的研究与实践	计算机教学部	吕晓燕 李祥生 韩玲革 闫 冰 张 伟
	SJ2018010	兆泰班改革实验班长期效果跟踪评价研究	网络中心	寒宪忠 刘丽芳 乔增杰 郭 峰 刘 龙 孙 鹏

山西医科大学教育教学改革项目

结 题 报 告

项目名称：山西省运动康复专业本科生培养模式的构建

项目类型：重点

项目主持人：赵良渊

资助金额：1 万元

起止年月：2017.12-2020.12

山西医科大学教务处

一、教学改革项目结题简表

<table>
<tr><td>项目名称</td><td colspan="5">山西省运动康复专业本科生培养模式的构建</td></tr>
<tr><td>项目主持人</td><td>赵良渊</td><td>专业技术职务</td><td>副教授</td><td>所在单位</td><td>山西医科大学</td></tr>
<tr><td colspan="6">项目主要研究人员名单</td></tr>
<tr><td>序号</td><td>姓名</td><td colspan="2">职称</td><td>专业</td><td>承担的任务</td></tr>
<tr><td>1</td><td>王建功</td><td colspan="2">讲师</td><td>体育教育训练学</td><td>构建模式</td></tr>
<tr><td>2</td><td>胡鑫</td><td colspan="2">讲师</td><td>体育教育训练学</td><td>数据收集</td></tr>
<tr><td>3</td><td>杜旭峰</td><td colspan="2">讲师</td><td>体育教育训练学</td><td>撰写论文</td></tr>
<tr><td>4</td><td>王东</td><td colspan="2">讲师</td><td>体育教育训练学</td><td>数据分析</td></tr>
<tr><td>5</td><td>闫旺旺</td><td colspan="2">学生</td><td>运动康复</td><td>问卷调查</td></tr>
<tr><td colspan="2" rowspan="2">研究时间</td><td colspan="2">立项年月</td><td colspan="2">2018 年 7 月</td></tr>
<tr><td colspan="2">完成年月</td><td colspan="2">2020 年 12 月</td></tr>
<tr><td rowspan="4">教学改革研究与实践成果</td><td colspan="5">如教学大纲、培养方案、课程标准、评价体系、教材（含音像教材）和教学软件课件、研究报告、论文著作等（可在以下栏目中分别详细列举）</td></tr>
<tr><td>1</td><td colspan="4">构建《山西省运动康复专业本科生培养模式（方案）》</td></tr>
<tr><td>2</td><td colspan="4">构建运动康复专业本科生教学培养任务</td></tr>
<tr><td>3</td><td colspan="4">《山西省运动康复专业建设与发展现状研究——以山西医科大学为例》</td></tr>
<tr><td></td><td></td><td colspan="4"></td></tr>
</table>

二、教学改革项目工作总结

一、研究内容、研究方法及研究措施

运动康复专业的蓬勃发展，是适应健康中国战略、现代体医融合潮流的大趋势。 由于我国运动康复专业起步晚，发展时间短，目前尚未有统一、成熟、科学的培养模式。因此，在办学过程中，各院校应该突出办学特色，加强实践教学。山西医科大学紧跟社会发展需求，于 2015 年招收山西省内第一届运动康复专业学生，到目前已连续招生 5 届。发展初期，学校在专业培养目标、课程设置、教学管理、学生就业等方面缺乏经验，如何建设特色鲜明的山西医学科大学运动康复专业培养体系充满机遇与挑战。

本研究通过文献资料法、专家访谈法、问卷调查法、数理统计法，对开设该专业的相关院校教师、专家、在校学生进行调查访谈。了解与掌握国内运动康复专业本科生培养模式，明确康复治疗专业与运动康复专业的关系和区别。掌握国际区域内运动康复专业人才培养、就业情况。为今后运动康复专业学生职业技能发展指明方向，并根据自身的实践经验提出问题与不足，以及针对性的解决对策。明确专业定位和培养目标，确定专业课程模式设置，完善教学保障体系。从而建立特色鲜明的山西医科大学运动康复专业本科生培养模式。

二、研究成果

1. 到目前为止，已连续招收 5 届运动康复专业学生，2015 级和 2016 级毕业生分别走向工作岗位，顺利升学等。通过理论与实践结合，已初步构建出《山西省运动康复专业本科生培养模式（方案）》。
2. 专业定位与学生培养目标不断明确，课程设置不断完善，教学内容逐渐合理，已完成运动康复专业本科生教学培养任务构建。
3. 运动康复专业实习基地构建完成，学生实习单位包括山西白求恩医院康复医学科、晋中市第一人民医院康复科、山西省运动康复基地、山西兴瑞女篮等。
4. 发表论文《山西省运动康复专业建设与发展现状研究——以山西医科大学为例》一篇。

三、研究成果的创新点和推广应用情况

创新点：该研究项目关乎我省运动康复专业本科生人才培养发展，在我省可起到带头引领导向作用，本研究对山西医科大学运动康复专业实践教学进行深入了解，在办学理念、课程设置、师资队伍建设、教学基础建设等方面发现不足。通过研究，了解国内外运动康复发展现状，掌握不同院校运动康复专业学生培养模式，为今后在实践教学体系构建方面提供借鉴与参考，建立山西省运动康复专业本科生培养模式，科学扎实的将我省运动康复专业人才培养落到实处。

四、本课题研究的存在问题与今后的研究设想

1. 缺乏本专业不同年级之间和毕业学生之间的纵向研究对比。
2. 在专业课程、课时设置，培养方案，学生就业情况等方面，缺乏与其他院校的横向研究。
3. 缺乏教学管理模式的探讨与研究
4. 缺乏问卷调查，例如实践教学问卷，学生专业知识能力问卷，就业工作情况问卷、师生访谈问卷等。
5. 今后的研究应该多方式调查，与相关院校之间增强交流，实地考察，为专业的建设提供更有价值的建议。

山西医科大学文件

山医大教〔2020〕9号

山 西 医 科 大 学
关于2020年度一流专业建设专项—卓越医生教育培养计划2.0指令性教改项目立项的通知

各教学单位，行政各部门，各教辅单位、重点科研单位、各附属单位：

为落实《山西医科大学高水平研究教学型医科大学建设实施方案》和《山西医科大学一流专业建设实施方案》精神，进一步推进我校一流专业建设和卓越医生教育培养计划实施，按照《山西医科大学卓越医生教育培养计划2.0教学改革实施方案》和《山西医科大学临床医学专业卓越医生教育培养计划2.0实施方案》要求，经个人申报、院系初评、学校审查、专家评审，决定确立2020年卓越医生教育培养计划2.0指令性教改项目15

项目编号	项目类型	项目名称	承担单位	项目负责人	资助金额（万元）
SXJ2020067	创新创业与实践教学	基于信息化平台三阶治教学模式在基础护理教学中的研究与实践	骨伤三生学院	贾晓荣	0.3
SXJ2020068		国际视野下地方本科医院创新创业教育生态系统研究	创新创业学院	周伯爱	0.5
SXJ2020069		虚拟仿真实验教学项目在医学线上教学中的应用	教务处	汤艳	0.3
SXJ2020070		基于3D建模的牙体牙髓实践教学模式研究	图书馆	郭凤珍	0.3
GXJ2020071	教学工作坊类	骨科XBL教学工作坊	第二临床医学院	刘昌文	0.5
SXJ2020072		大健康模式下PBL教学工作坊	基础医学院	张轩萍	0.5
GXJ2020073		自我驱动与自我成长教学工作坊	药学院	杨雪娟	0.5
GXJ2020074		护理学模块化Jigsaw教学工作坊	护理学院	闫英	0.5
SXJ2020075		高校医学生继续教育与就业指导工作坊	口腔医学院	郭建永	0.5
SXJ2020076	新医科类	新医科医工融合背景下“纳米生物医药”仿真开放课程的设计与实践	基础医学院	王宁	0.3
SXJ2020077		以“新医科”医理融合为视角的医药物理学混合课程构建与实践	基础医学院	杨光跨	0.3
SXJ2020078		医学高校学生科学数据素养教育课程体系建设与教学实施的探索	管理学院	邹伯芳	0.3
SXJ2020079		新医科背景下医科院校大数据相关课程教学改革探索	管理学院	吴娟	0.3
SXJ2020080		构建“互联网+”人机交互实训系统优化医学人才影像实践培养模式	医学影像学院	江志芳	0.5
SXJ2020081		基于“互联网+”的临床医学新形态课程体系建设与应用研究	医学影像学院	李立恒	0.3
SXJ2020082		新医科背景下生物物理学医理融合课程体系的建设研究	医学影像学院	乔志坚	0.3
SXJ2020083		基于大数据平台下医科类院校公共体育课堂课程改革研究—以山西医科大学为例	体育教学部	杜纪峰	0.5
SXJ2020084		新医科背景下基于移动云平台的医学研究数据库技术课程资源建设及SPOC教学实践	计算机教学部	吕晓英	0.3
GXJ2020085	其它	儿科医学“朋友圈”带教计划和实施模式的探索研究	第一临床医学院	曹丽娟	0.5
GXJ2020086		基于e-教学平台的儿科学课程的形成性评价研究	第一临床医学院	武海娟	0.3
GXJ2020087		《妇产科学》中异位妊娠教学案例库建设与应用研究	第二临床医学院	郑冲霄	0.5
GXJ2020088		开展儿科学临床医学“朋友圈”带教计划的实施模式研究	第二临床医学院	董蓉	0.3
SXJ2020089		Two-stage scaffold应用于组织胚胎学实验性学习评价的实践研究	基础医学院	曹海燕	0.3

山西医科大学运动康复专业

“一基两翼”课程体系

成

果

总

结

山西医科大学

二〇二一年五月

山西医科大学运动康复专业
“一基两翼”课程体系成果总结

运动康复专业是新兴的体育、健康和医学交叉结合的前沿学科，是适应社会对健康及康复的需求而设立的体育与医学交叉的新兴特设专业。我校运动康复专业将始终以国家大力发展体医融合为契机，以我校得天独厚的医学资源为优势，充分发挥体育的作用，按照高技能和高素质的人才培养要求，继续加强师资队伍建设和教学条件建设，不断优化本专业人才培养方案，探索更加科学的课程体系，不断改进教学方法与教学手段，加大实验室建设力度，努力提升社会服务能力，立足山西、面向全国，为康复医疗机构、运动队、康养中心、科研院所以及普通人群的健康指导等培养复合应用型专门人才，坚持将运动康复专业建设成省内示范、国内领先、特色鲜明的本科专业。

专业建设的核心是人才培养，人才培养的关键的课程建设，我校运动康复专业将体育与医学有机结合，根据学校及学生实际情况，结合社会对运动康复专业人才需求，大胆创新，不断探索，制定出适应社会发展的特有的“一基两翼”课程体系，即一基：基础医学通识类课程，两翼：体育类课程、康复类课程。根据运动康复专业的培养目标、办学定位所设置课程涵盖了包括基础医学通识类课程、体育类课程和康复类课程的三大方面，且高度融合，既借助我校一流的医学硬件软件优

势，又将基础医学、运动、康复类课程相融合，充分体现健康中国，体医融合的大背景，符合国家对运动康复专业学生的需求。

“一基两翼”课程体系构建

运动康复专业自2015年开始招生，课程体系在2013年开始就多次组织相关教师外出调研培训，向运动康复、运动医学等方面的相关专家请教，向发展好的兄弟院校学习，再结合我校运动康复专业的具体情况对运动康复专业的课程设置进行11次修订完善，同时完成4次专家论证，现阶段我部运动康复专业按照学校所有专业的专业课程设置模块安排，将运动康复专业课程模块划分为通识课程、医德与人文教育课程、专业基础课程、专业核心课程、专业限定选修课五部分（见附件1山西医科大学运动康复专业课程设置），其中专业基础课程18门，专业核心课程28门。教学任务主要在1-6学期完成，第七、八学期主要进行专业实习和毕业论文的撰写。根据运动康复专业课程的基础类课和核心课程内容，我们将运动康复专业的课程划分为基础类课程、体育类课程、康复类课程，并将其命名为具有专业特色的“一基两翼”的课程体系。其框架构建为：

基础课程	体育类课程	康复类课程
运动解剖学	运动训练学	人体发育学
细胞生物学	田径	运动营养学
心理学	体操	医务监督
生物化学	篮球	康复功能评定学
运动生理学	排球	肌肉骨骼康复学
病理学	武术	运动急救
医学影像学	体育概论	贴扎术
药理学	足球	运动处方
运动生物力学	体育舞蹈	针灸学
诊断学	小球运动（乒乓球）	物理治疗学
内科学基础	小球运动（羽毛球）	运动损伤康复
外科学基础	健美操	运动疗法技术学
中医基础理论	专业英语	康复心理学
医学信息检索与利用	游泳运动	拉伸术
医学伦理学	跆拳道	中医养生康复
组织胚胎学	体育统计学	推拿与按摩
	拉伸术	运动康复器械组合训练
	核心功能训练	
	体育科学研究方法	

“一基两翼”课程体系的特色优势

目前全国开设运动康复专业的院校主要有医科类院校、体育类院校、师范类院校、综合类院校和独立院校等，因此各高校的人才培养呈现百花齐放、百家争鸣态势。针对如何培养社会所需要的应用型运动康复人才，学者们进行了大量分析研究，主要集中在人才培养模式、存在问题、现状分析和教学改革等方面。作为人才培养的核心要素，课程的建设水平和质量直接决定人才培养质量。目前不同的院校在运动康复专业课程体系建设上存在一定的差异，体育类院校主要以运动人体科学作为基础，课程设置以体育理论知识和运动技能为主要课程；

医学类院校主要以医学资源为背景，体育类课程相对较少，综合类院校也是在体育教学的基础上进行课程设置，不同院校的课程体系建设基础不同，课程体系建设存在一定的偏差。

通过调查研究分析，我校运动康复专业按照国家及社会需求，根据《高等学校本科专业类教学质量国家标准》规定及专业培养目标、办学定位等，结合我省、我校的专业需求及特点，大胆尝试创新，制定了具有专业特色的“一基两翼”的课程体系，其课程设置将基础医学、体育、康复三部分内容融入运动康复专业课程体系中，适当增加课程的实践教学及实习时间，整体课程建设高度融合。独特、全面的课程体系建设适当弥补了体育类院校医学康复类课程的缺失和医科类院校运动类课程的缺失等。

作为医科类院校，医学教学资源是我们的优势，运动康复专业基础类课程基本由我校经验丰富的基础医学院、第一临床医学院、管理学院、公共卫生学院、医学影像学院等教学团队来承担，专业的教学团队和一流的实验室使得学生学习基础类知识的热情高涨。我校运动康复专业康复类课程主要由我校附属医院有很强临床经验的医师团队来承担，丰富的临床经验使教学课堂充满无限乐趣，理论与实践的完美结合为专业实习打好坚实的基础。同时学校丰富的教学实习基地以及校企合作、校局合作等等为学生的实习提供了有利保障。

“一基两翼”课程体系的主要成果展现

1、教师及学生对“一基两翼”课程体系的满意度调查

我校运动康专业建立教学质量标准，完整的教学质量保障的监控体系，完善的教学评价和反馈系统听过听课评价、学期末问卷评价、主任信箱等形式及时反馈教学质量监控信息，设置专门的课程体系满意度调查，通过不断的调查分析，结合社会需求及学校学生特点，不断的修订培养方案，目前学生及教师对“一基两翼”的课程体系认可度非常高，2020 年运动康复专业成为省级一流专业，为继续加强一流专业建设，我们还将不断完善，追求卓越。

2、专家对“一基两翼”课程体系的认可

我校运动康复专业的课程体系进行 11 次修订完善，同时完成 4 次专家论证。北京体育大学矫伟教授、山西白求恩医院康复医学科主任梁英教授以及武俊英教授、美国伊斯卡大学关红卫教授等国内外专家对我校运动康复专业的课程体系进行过专业论证，在每一次的论证中，专家对“一基两翼”的课程体系表示赞同，同时在课程的删减上给出很多有价值的建议。

3、“一基两翼”课程体系建设有利于学生的实习及就业

我校运动康复专业学生毕业的去向主要有专业运动队、各级医院的康复机构、体育运动基地、健康休闲俱乐部、职业运动俱乐部、康养中心、社区、健康与康复科研所、体育与卫生行政部门等机构，专业从事康复治疗、健康教育、健康测定与

评估、健身指导、卫生保健、医疗监督、科学研究及行政管理的工作。运动康复专业学生可以成为康复技师、运动防护师、体能训练师等等。目前，我校运动康复专业的实习基地在依托我校20多个附属医院的基础上，还有山西省体育局、各运动队、其他医院等，我们还将不断拓展康养中心、社区、专业康复机构等，在不同的实习基地，学生们将理论与实践的有机结合，实践能力不断增强，受到各个实习基地的一致好评，学生就业前景一片光明，截至目前已有毕业生两届，就业率高达90%以上，就业单位主要有康养中心、职业俱乐部、各种康复机构、医院康复科、自主创业使用所学自建康复中心等等。

4、“一基两翼”课程体系有利于一流专业的建设

在全面加快建设全国该水平本科教育，全面提高人才培养能力的感召下，为努力建设国家级一流专业，培养一流人才，提高运动康复专业人才培养能力。我校运动康复专业紧扣国家发展需求，不断优化专业结构，努力致力于打造具有专业特色的优势专业。2020年11月，我校运动康复专业“一基两翼”课程体系获得中国康复医学会三等奖。同时“一基两翼”课程体系是我校运动康复专业一流专业申报的特色及优势所在，是一流专业建设的主要组成部分。我校运动康复专业现为省级一流专业，我们将按照“国家一流本科课程”标准，依据课程目标，结合运动康复专业特点及社会需求，继续加大申报力度，向国家级一流专业努力冲刺。

5、“一基两翼”课程体系有利于社会服务的广泛开展

我校运动康复专业一直致力于加强运动康复社会服务方面的工作。在特有的“一基两翼”课程体系下培养的学生将更符合国家运动康复专业人才需求，有利于加强与省体育局、太原市体育局的合作，与山西省各职业俱乐部的合作，与司法厅戒毒所的合作，与部队在体适能训练方面的合作，与医院的合作、与康养中心的合作、与健身指导会所等等的合作。这些关系的建立将更好的为专业的社会服务工作、为学生的实习、就业提供有力的保障。2019 年 10 月由我校运动康复专业学生自发组成山医大运动康复工作室成立，此工作室是在学生社团兼学生实践基地，在 2019 年 10-11 月受山西省教育厅、山西省体育局委派承担 2019 年山西省校园足球赛、第二十二届 CUBA 基层赛的医务保障工作，圆满完成保障工作，受到各个代表队的一致好评，同时山西省教育厅、山西省体育局授予我校运动康复专业突出贡献奖称号。

二〇二一年五月

山西医科大学运动康复专业

“一基两翼”课程体系

成

果

及

相

关

支

撑

材

料

山西医科大学

二〇二一年五月

中国康复医学会文件

中康发〔2020〕80号

关于表彰2020年度中国康复医学会教学成果奖获奖项目的通报

各分支机构，各省、自治区、直辖市康复医学会，各单位会员：

2020年，广大康复医学教学工作者认真贯彻立德树人理念，努力提高教学能力，积极投身教学实践和教学研究，产出了一批优秀教学成果，根据《中国康复医学会教学成果奖励管理办法》，经组织专家评审，共评出教学成果奖22项，其中一等奖6项、二等奖8项、三等奖8项，经公示后无异议，现予以通报表彰。

一、一等奖（共6项）

1. 发挥学科优势，创建应用型康复治疗一流本科专业的改革与实践

主要完成单位：福建中医药大学、福建中医药大学附属康复医院、中国科学院深圳先进技术研究院、深圳华鹊景医疗科技有

中国康复医学会教学成果奖

证 书

奖 励 项 目：山西医科大学运动康复专业“一基两翼”课程体系建设

主要完成单位：山西医科大学

奖 励 等 级：三等奖

证 书 编 号：JXCG-2020-3-8-U0101

中国康复医学会

2020年10月21日

证书号第7686589号

北京市海淀区地方税务局 印花税 代扣专用章 国家知识产权局

实用新型专利证书

实用新型名称：充气电疗式踝关节保养装置

发　明　人：赵良渊;王建武;王建功;杜旭峰;胡鑫;张天光

专　利　号：ZL 2017 2 0646236.1

专利申请日：2017年06月06日

专利权人：山西医科大学

地　　址：030001 山西省太原市新建南路56号

授权公告日：2018年08月07日　　授权公告号：CN 207693874 U

本实用新型经过本局依照中华人民共和国专利法进行初步审查，决定授予专利权，颁发本证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。

本专利的专利权期限为十年，自申请日起算。专利权人应当依照专利法及其实施细则规定缴纳年费。本专利的年费应当在每年06月06日前缴纳。未按照规定缴纳年费的，专利权自应当缴纳年费期满之日起终止。

专利证书记载专利权登记时的法律状况。专利权的转移、质押、无效、终止、恢复和专利权人的姓名或名称、国籍、地址变更等事项记载在专利登记簿上。

局长
申长雨

国家知识产权局

2018年08月07日

证书号第6985072号

实用新型专利证书

实用新型名称：手部康复训练器

发　明　人：赵良渊;王建武;王建功;杜旭峰;胡鑫;张天光

专　利　号：ZL 2017 2 0887818.9

专利申请日：2017年07月21日

专利权人：山西医科大学

授权公告日：2018年02月13日

本实用新型经过本局依照中华人民共和国专利法进行初步审查，决定授予专利权，颁发本证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。

本专利的专利权期限为十年，自申请日起算。专利权人应当依照专利法及其实施细则规定缴纳年费。本专利的年费应当在每年07月21日前缴纳。未按照规定缴纳年费的，专利权自应当缴纳年费期满之日起终止。

专利证书记载专利权登记时的法律状况。专利权的转移、质押、无效、终止、恢复和专利权人的姓名或名称、国籍、地址变更等事项记载在专利登记簿上。

局长
申长雨

中华人民共和国国家知识产权局

2018年02月13日

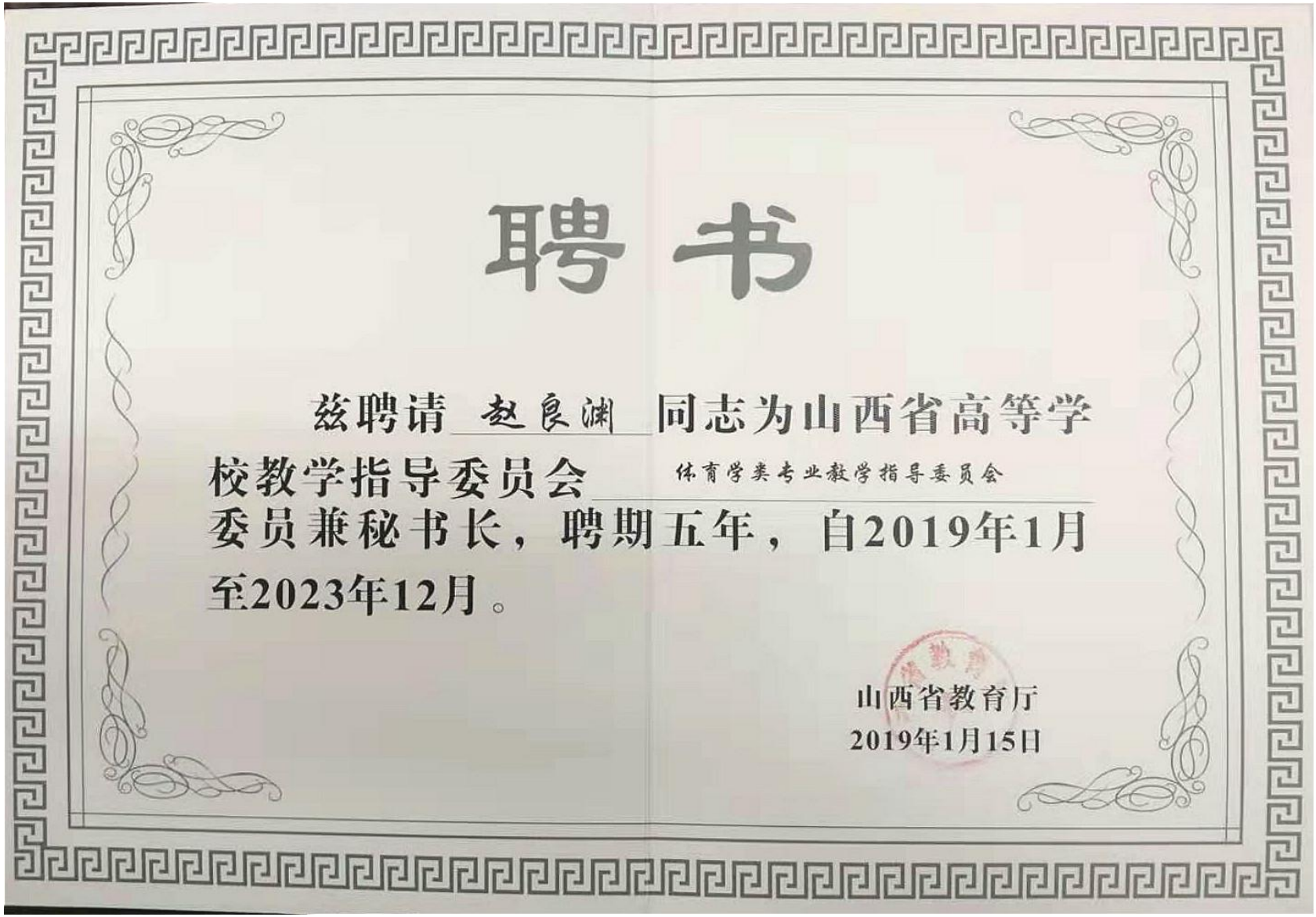
证书编号：2018020412

山西省“三晋英才”支持计划
入选证书

赵良渊 同志

入选2018年度山西省“三晋英才”
支持计划拔尖骨干人才

中共山西省委人才工作领导小组
二〇一九年三月



聘书

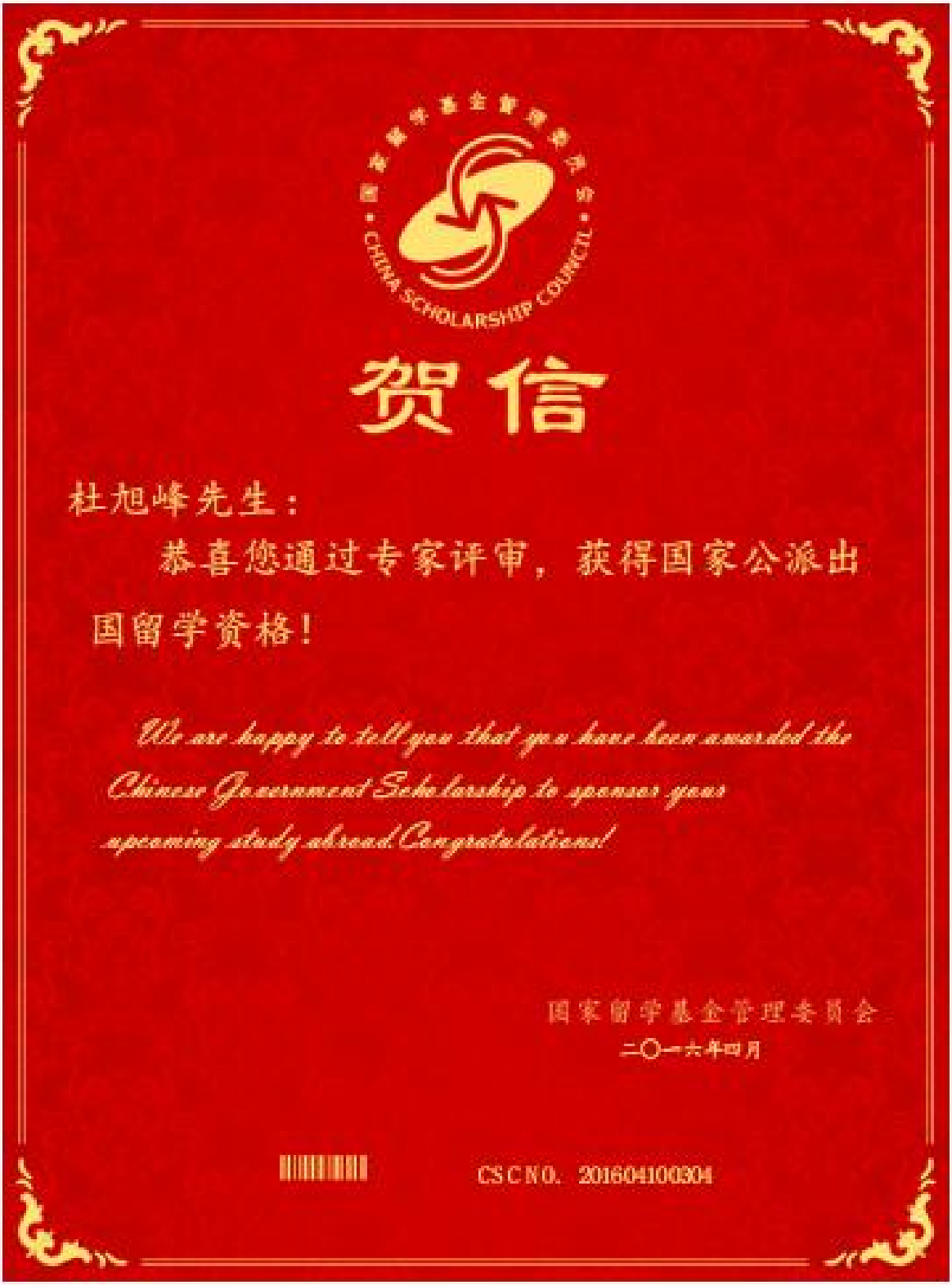
兹聘请 赵良渊 同志为山西省高等学校教学指导委员会 体育学类专业教学指导委员会委员兼秘书长，聘期五年，自2019年1月至2023年12月。

山西省教育厅

2019年1月15日


SHANXI 2019
中华人民共和国第二届青年运动会
THE 2ND YOUTH GAMES OF THE PEOPLE'S REPUBLIC OF CHINA
荣誉证书
授予 赵良渊 同志：
“第二届全国青年运动会组织筹办
工作先进个人”称号。
特颁此证，以资鼓励。
山西省人力资源和社会保障厅
山西省体育局
第二届全国青年运动会
组织委员办公室
2019年10月14日


SHANXI 2019
中华人民共和国第二届青年运动会
THE 2ND YOUTH GAMES OF THE PEOPLE'S REPUBLIC OF CHINA
荣誉证书
授予 杜旭峰 同志：
“第二届全国青年运动会组织筹办工作先进个人”称号。
特颁此证，以资鼓励。
山西省人力资源和社会保障厅
山西省体育局
第二届全国青年运动会组织委员会办公室
2019年10月14日


CHINA SCHOLARSHIP COUNCIL
贺信
杜旭峰先生：
恭喜您通过专家评审，获得国家公派出国留学资格！
We are happy to tell you that you have been awarded the Chinese Government Scholarship to sponsor your upcoming study abroad.Congratulations!
国家留学基金管理委员会
二〇一六年四月
CSC NO. 201604100304

1st 4sport Qualifications

The FA

UKCC

This is to certify that

Xufeng Du

has been awarded the

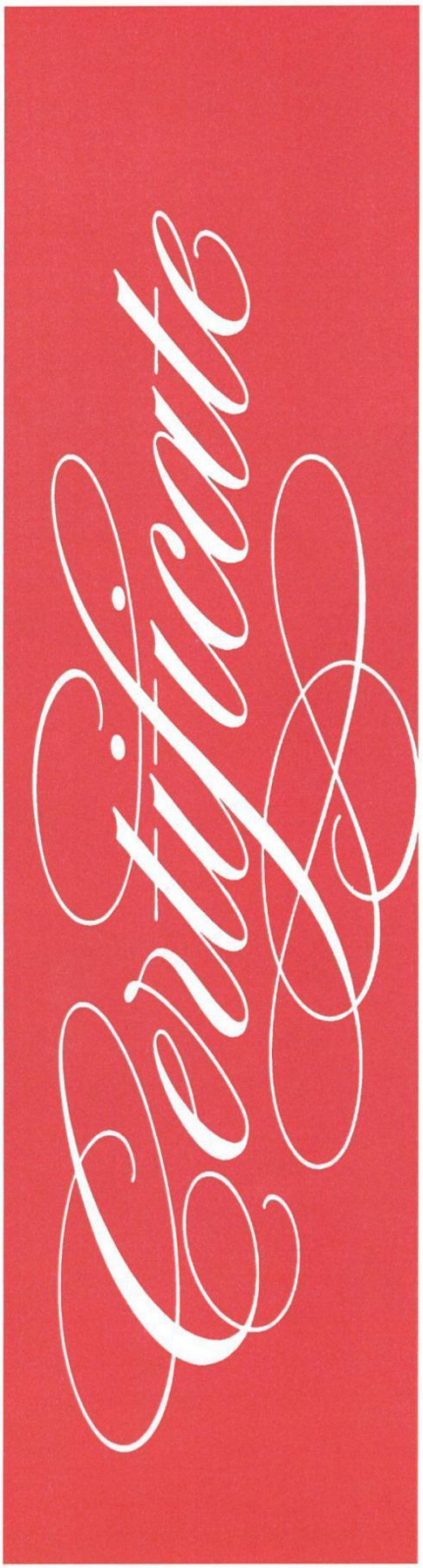
The FA Level 1 in Coaching Football

Certificate Date: 22/08/2016

Signed

Chris Earle
Head of FA Education
St George's Park
The FA Group

00192802



STAFFORDSHIRE UNIVERSITY

The 2016 Chinese Campus Football Coaches Study in the UK Programme in partnership with Staffordshire University

2016 年中国校园足球教练员赴英国留学项目

Certificate of Attainment

Xufeng Du

This certifies your successful completion of the programme **at Staffordshire University** in partnership with **Stoke City FC** during the period of:
27 June – 15 September 2016

Signed:

Professor Liz Barnes
Vice Chancellor

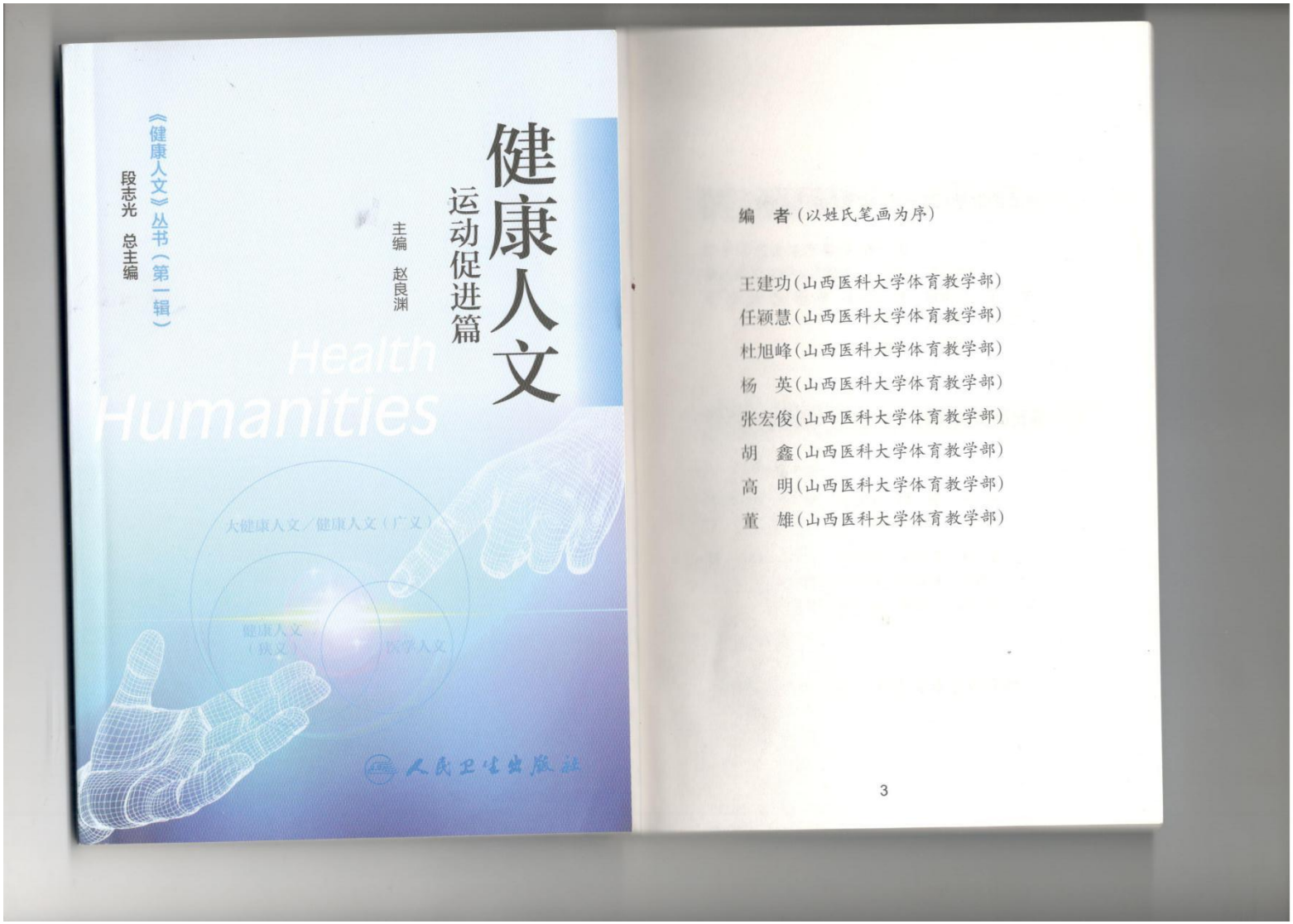
Tony Scholes
Chief Executive

Date: **15 September 2016**

STOKE CITY 1863 THE POTTERS

CSSF

FUSC



编 者（以姓氏笔画为序）

王建功（山西医科大学体育教学部）
任颖慧（山西医科大学体育教学部）
杜旭峰（山西医科大学体育教学部）
杨 英（山西医科大学体育教学部）
张宏俊（山西医科大学体育教学部）
胡 鑫（山西医科大学体育教学部）
高 明（山西医科大学体育教学部）
董 雄（山西医科大学体育教学部）


Health
Humanities
健康人文：基本理念篇
健康人文：围产期关怀篇
健康人文：营养卫生篇
健康人文：食品安全篇
健康人文：运动促进篇
健康人文：心理关怀篇
健康人文：老年关怀篇
健康人文：亚健康关怀篇
健康人文：医患沟通篇
健康人文：应急关怀篇
健康人文：失能关怀篇
健康人文：医务社工篇
健康人文：医疗保险篇
健康人文：健康产业篇
健康人文：医者情怀篇
健康人文：大学生健康管理篇
策划编辑 常 帆
责任编辑 常 帆
肖宛凝
封面设计
赵京津
版式设计 白亚萍
人卫智网
www.ipmph.com
医学教育、学术、考试、健康，购书智慧智能综合服务平台
人卫官网
www.pmph.com
人卫官方资讯发布平台
关注人卫健康 提升健康素养
ISBN 978-7-117-25687-2
定 价：12.00 元

Microchemical Journal 145 (2019) 308–312

Contents lists available at ScienceDirect

Microchemical Journal

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

Research on determination of BTEX in human whole blood using purge and trap-gas chromatography-mass spectrometry combined with isotope internal standard

Liangyuan Zhao[a,1], Xiaojiang Qin[b,*,1], Xiaomin Hou[c], Yanhua Li[d], Kun Zhang[e], Wei Gong[b], Jisheng Nie[b], Tong Wang[b]

[a] Department of Exercise Rehabilitation, Shanxi Medical University, Taiyuan, Shanxi, China
[b] School of Public Health, Shanxi Medical University, Taiyuan, Shanxi, China
[c] Department of Pharmacology, Shanxi Medical University, Taiyuan, Shanxi, China
[d] Department of Foreign Language Teaching, Shanxi Medical University, Taiyuan, Shanxi, China
[e] Department of Pharmacy, Shanxi Medical University, Taiyuan, Shanxi, China

ARTICLE INFO

Keywords:
BTEX
Human whole blood
Purge and trap
Gas chromatography-mass spectrometry
Isotope internal standard

ABSTRACT

To develop a method to measure simultaneously the concentration of BTEX (benzene, toluene, ethylbenzene, *m/p*-xylene, *o*-xylene) in human whole blood with Purge and Trap-Gas Chromatography-Mass Spectrometry. The conditions of purge and trap were optimized, so that the BTEX in human whole blood could be enriched and desorbed, and then characteristic ions could be selected with gas chromatography–mass spectrometry combined with isotope internal standard for qualitative and quantitative analysis. After the parameters of purge and trap method were optimized, the BTEX in human whole blood could be simultaneously enriched, desorbed and measured accurately. The detection limit with this method ranges from 0.001 μg/L to 0.004 μg/L. The Linear range is from 0.021 μg/L to 10.99 μg/L. The recovery rate of low concentration (0.687 μg/L) solution is in the range of 79.21% to 85.92%; the recovery rate of high concentration (2.747 μg/L) solution is in the range of 93.21% to 102.07%. The analysis of the same sample is repeated for six times with its relative standard deviation ranging from 2.77% to 5.40%. With simple operation, short analysis period, good separation as well as required accuracy and precision, this method could analysis of BTEX concentration in human whole blood.

1. Introduction

BTEX (benzene, toluene, ethylbenzene, *m/p*-xylene, *o*-xylene) are important raw materials and solvents in industries of chemistry, medicine, pesticide, tanning leather etc. [1–4]. The pollutants benzene, toluene, ethylbenzene, xylenes (BTEX) represent an important group of airborne contaminants [5]. The BTEX have become an important occupational hazard factor with the features of strong volatility, extensive existence and easy absorptivity [6]. The BTEX can harm human health seriously [7,8]. For instance, they can injure the hematological system and cause teratogenesis as well as cancer [9–11]. Therefore, how to assess the internal dose of BTEX in human whole blood has become a hot issue and an urgent problem in environmental medicine.

Compared with water and air samples, human whole blood samples have very complex components and physical-chemical properties [12,13]. The interference factors in a series of processes of blood sampling, storage and testing have to be controlled strictly, so that reliable and accurate data can be obtained and provided to Centers for Disease Control. The BTEX in the blood are poisonous organic pollutants even in trace amounts [14], and they have to be tested by techniques with high enrichment efficiency and high sensitivity. Therefore, Purge and Trap technology(P&T)was adopted in this experiment to enrich volatile BTEX efficiently in human whole blood. The limit of detection (LOD) in analysis methods can be reduced, and the organic solvent and extraction matrix are not needed any more, thus secondary pollution caused by the interaction of organic solvents and certain ingredients in blood samples can be avoided. In this experiment, purge and trap conditions were optimized, including purge temperature and time, desorption temperature and time. With its high sensitivity and extensive application, Chromatography-Mass Spectrometry (GC/MS)

* Corresponding author at: Shanxi Medical University, Taiyuan, Shanxi 030001, China.
E-mail address: sph@sxmu.edu.cn (X. Qin).
[1] These authors have contributed equally to this work.

https://doi.org/10.1016/j.microc.2018.10.038
Received 20 July 2018; Received in revised form 14 September 2018; Accepted 18 October 2018
Available online 23 October 2018

has been adopted extensively in analyzing Volatile Organic Compounds (VOCs) in water or air [15,16].

The chemical properties of isotope internal standard compounds and that of target compounds are almost the same, as a result, their enrichment efficiency, loss degree, and matrix effects in testing agree completely [17]. Due to the agreement, isotope internal standard compounds can be used to rectify the testing deviation of analysis methods.

To date, it has not been reported that Purge and Trap-Gas Chromatography-Mass Spectrometry (P&T-GC–MS) combined with isotope internal standard was applied to testing the BTEX in human whole blood. Therefore, the method of P&T-GC–MS combined with isotope internal standard was adopted to measure the BTEX concentration in human whole blood. Appropriate instrument conditions were chosen and optimized in this research. The project provided a scientific basis for internal dose assessment of BTEX in human body.

2. Materials and methods

2.1. Instruments and reagents

2.1.1. Main instruments

Gas chromatography-mass spectrometer: TSQ QUANTUM XLS ULTRA 03947 (Thermo Fisher Scientific, USA); Purge & Trap Concentrator: Strtum PTC (Tekmar, USA); Purg & Trap Auto-sampler: AQUA Tek 100 (Tekmar, USA); DB-624: Flexible quartz capillary tube chromatographic column (Agilent, USA);

2.1.2. Reagents

Standard mixed solutions of BTEX, 10 mg/L; mixed solutions of five isotopic internal standard compounds, 200 μg/L; high-purity nitrogen, with purity ≥ 99.999%; appropriative methanol for volatile organic compounds, analytical grade purity, with purity ≥ 99.8%; newly-made ultrapure water (by Sigma, USA); Antifoam 204, a nonsilicone defoamer, with purity ≥ 99.0% (by Sigma, USA).

2.1.3. Gas chromatography–mass spectrometry conditions

Chromatographic column: DB-624 capillary chromatographic column (30 m × 0.25 mm × 1.4 μm); Column temperature: the initial temperature was 40 °C, lasted for 3 min, rose to 150 °C with a speed of 10 °C/min, and lasted for 0.5 min, then rose to 210 °C with a speed of 15 °C/min, lasted for 4 min; Split injection, with a split ratio of 20:1; The temperature of injection port: 250 °C; Carrier gas: nitrogen (99.999%); Constant current mode, carrier gas flow: 1.2 mL/min; Ion source type: EI; Ion source temperature: 250 °C; Transmission line temperature: 280 °C; Electron impact energy of mass spectrometer: 70 eV [18]; Retention time of each compound was determined with a full scan model; The value of mass spectra peak was determined with SIM model, and the selected ions were shown in Table I.

2.1.4. Sample collection and preservation

Blood samples were collected with venipuncture and put into 7 mL vacuum blood collection tubes, then gently mixed up and down for 20 times so that the crystalline heparin sodium/sodium fluoride inside can dissolve fully, which minimizes clotting. After sampling, the blood samples in the vacuum blood collection tubes were gently poured into 5 mL brown glass vials so that the vials were completely filled and tightened with a cap with a white Teflon gasket. Samples were preserved at 4 °C and analyzed within 10 weeks after sampling.

Table I
Analysis parameters used to assess BTEX.

Retention time (min)	Compound	Quan ion (*m/z*)	Isotope	Quan ion of isotope (*m/z*)
4.83	Benzene	78	D_5	83
6.90	Toluene	91	D_5	97
8.65	Ethylbenzene	91	D_{10}	98
8.79	*m/p*-Xylene	91	D_{10}	98
9.40	*o*-Xylene	91	D_4	95

2.1.5. Standard solution preparation

A certain amount of mixed solution was added to methanol to prepare the standard series solutions by stepwise doubling dilution. The standard series solutions with concentrations of 2198, 1099, 549.5, 274.8, 137.4, 68.69, 34.34, 17.17, 8.586, 4.293, 0 μg/L were made. Standard series solutions of 200 μL was first put into 40 mL sample bottles, and then was added 5 mL of blank blood, 200 μL isotope internal standard compounds, and a drop of defoamer (20 drops for 1 mL) at the same time, finally added 20 mL of pure water, then shook up and down for 20 times, at last filled with pure water and sealed the sample bottles. A standard series of solutions with a gradient of 10.99, 5.495, 2.748, 1.374, 0.6869, 0.3434, 0.1717, 0.08586, 0.04293, 0.02146, 0 μg/L were obtained and then shaken in the ultrasonic oscillator for 1 min before being measured in the instruments [19–21].

2.1.6. Sample determination

Blood samples of 5 mL was first put into 40 mL sample bottles, and then was added 200 μL isotope internal standard compounds and a drop of defoamer at the same time, finally added 20 mL of pure water, then shook up and down for 20 times, at last filled with pure water and sealed the sample bottles. The bottles were shaken in the ultrasonic oscillator for 1 min before being measured in the instruments.

2.1.7. Calculation formula

The formula of BTEX concentration in blood is as follows:

$$Ci = Cis \times 40/5$$

In this formula:

Ci: the concentration of compounds measured in actual samples, μg/L;

Cis: the concentration of compounds measured with standard curve, μg/L.

3. Results

3.1. Optimization of purge and trap parameters

In order to save time and improve efficiency, 11 min was adopted as the purge time (11–15 min is the common purge time). The results suggested that 40 mL/min was optimum condition for purge flow rate. As shown in Fig. 1A.

The change trends of individual chromatographic peak areas at different purge temperatures are shown in Fig. 1B. Purge temperature of 40 °C was finally chosen to prevent protein denaturation.

The results suggested that the change trends of individual chromatographic peak areas at different desorption temperatures are shown in Fig. 1C. The desorption temperatures of 250 °C was chosen to protect trap and adsorbents.

The change trends of individual chromatographic peak areas at different desorption time are shown in Fig. 1D. The results suggested that the chromatographic peak areas increase with the increase of desorption time in the range of 1–2.5 min; and the chromatogram peak areas tend to be stable with temperatures time longer than 2.5 min. Desorption time of 2.5 min was chosen to protect adsorbents.

It was verified that the blocking of instruments was significantly relieved after the cleaning cycle had been conducted for three times. It was verified that baking for 2 min can cause complete evaporation of residues. Thus, the baking temperature of 280 °C and baking time of 2 min were chosen.

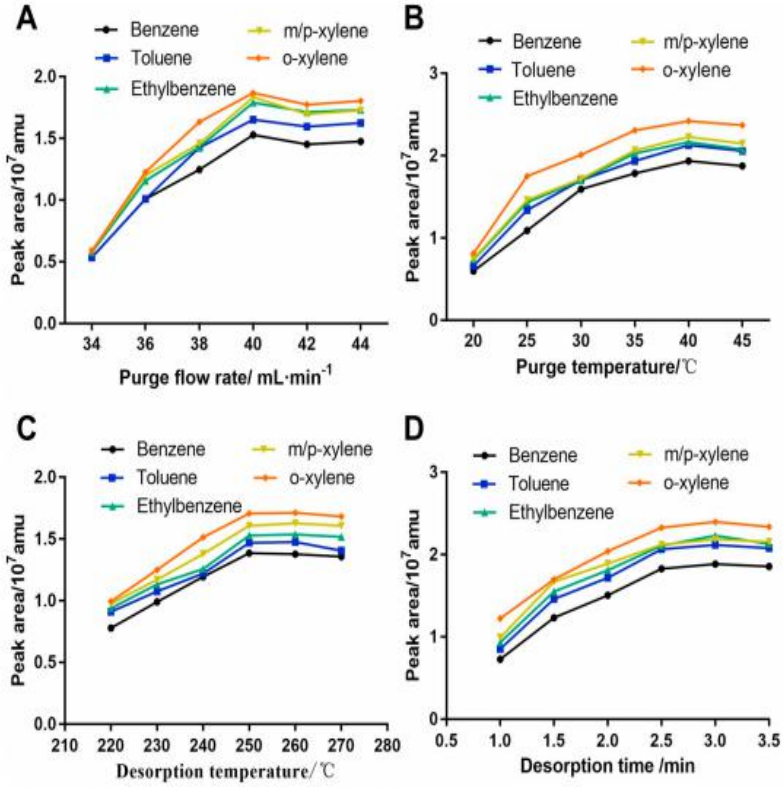


Fig. 1. Optimization of purge and trap parameters. A: Effect of purge flow rate on chromatographic peak areas; B: Effect of purge temperature on chromatographic peak areas; C: Effect of desorption temperatures on chromatographic peak areas; D: Effect of desorption time on chromatographic peak areas.

3.2 *Chromatogram of selected ions*

Fig. 2 is the chromatogram of selected ions in the standard solution with a concentration of 1.563 μg/L. The results indicate that the five peaks have been well separated (*m/p*-xylene are included in the same peak).

3.3. *Linear range and detection limit*

A series of standard solutions were prepared as following described in the experimental method section and were tested in above-mentioned experimental conditions to get a ratio of peak areas between

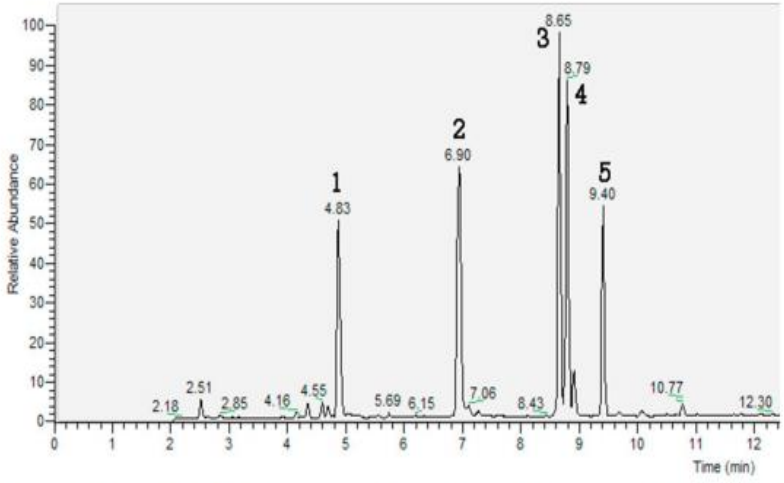


Fig. 2. Chromatogram of selected ions in the standard solution. 1: -benzene; 2: -toluene; 3: -ethylbenzene; 4: -*m-p*-xylene; 5: -*o*-xylene.

Table II
Linear equations, correlation coefficients and detection limits.

Compound	Linear equation	Linear range (μg/L)	R^2	LOD (μg/L)	LOQ (μg/L)
Benzene	Y = 4.83672X + 0.189722	0.021–10.99	0.9997	0.002	0.006
Toluene	Y = 5.64538X − 0.163331	0.021–10.99	0.9988	0.003	0.010
Ethylbenzene	Y = 4.20093X − 0.230083	0.021–10.99	0.9986	0.004	0.013
m/p-Xylene	Y = 4.09391X − 0.098832	0.021–10.99	0.9992	0.002	0.006
o-XYLENE	Y = 5.89896X − 0.210065	0.021–10.99	0.9991	0.001	0.003

each standard solution. The standard curve of each substance was plotted with the concentration (μg/L) as the abscissa and the peak area ratio as the ordinate. The results are shown in Table II.

3.4. Recovery rate and precision

Blank blood samples were taken to prepare two solutions with high concentration (2.747 μg/L) and low concentration (0.687 μg/L) respectively, which then were tested in the instruments. The recovery rates were then calculated separately, and the precision of six parallel samples was calculated for each concentration. The results are shown in Table III.

For the analysis of biological samples, relative standard deviation (RSD) was required to be < 20% and the recovery rate was required to fall in the range of 70% to 130%. The experimental results corresponded to the above-mentioned criteria, showing that this method can meet the determination requirements of monitoring and analyzing BTEX.

4. Discussion

BTEX are the major VOCs found in the environment emitted mainly from paint manufacturing, chemical and petrochemical industries [22]. BTEX account almost 80% of the total VOCs from petrochemical emissions [22]. In this study, the method of P&T-GC–MS combined with isotope internal standard was adopted to measure the BTEX concentration in human whole blood. Appropriate instrument conditions were chosen and optimized in this research. Purge and Trap parameters were optimized including purge flow rate, purge temperature, desorption temperature, desorption time, baking temperature, and baking time.

Common purge time ranges from 11 to 15 min. In order to save time and improve efficiency, 11 min was adopted as the purge time. The larger the purge flow rate is, the higher the purge efficiency will be. However, if the purge flow rate is too large, the compounds trapped in the cold trap will be blown off or blown away, reducing the purge efficiency. It has been verified that 40 mL/min can maximize the purge efficiency.

Purge temperature has a greater effect on purge efficiency especially when highly water-soluble compounds are purged. Raising purge temperature increases purge efficiency and shortens purge time. But too high purge temperatures will lead to too much water vapor being purged, which is not conducive to the adsorption of compounds in the cold trap. What's more, high moisture will result in a decrease in the separation efficiency of the polar gas chromatographic column and damage its service life [23]. For VOCs in water, common purge temperatures range from 20 to 50 °C. But for VOCs in blood, temperatures higher than 40 °C will lead to deformation of proteins [24], even blocking the pipes. Therefore, we chose 40 °C as the purge temperature.

The higher the desorption temperature is, the higher the purge efficiency will be [25]. What's more, high desorption temperatures are conductive to the formation of sharp symmetrical chromatographic peaks. But if the desorption temperature was too high, the service life of trap and adsorbents will be reduced. Common desorption temperatures range from 200 °C to 300 °C. It has been verified that the purge efficiency of 250 °C was high enough. Therefore, we chose 250 °C as the purge temperature to protect the trap and adsorbents.

The longer the desorption time is, the higher the purge efficiency will be [26,27]. But overlong desorption time will reduce the service life of the adsorbents and lead to chromatographic peak tailing. Common desorption time ranges from 1 to 3 min. It has been verified that the purge efficiency of 2.5 min was high enough. Therefore, we chose 2.5 min as the purge time.

The compositions in blood were complex with a large number of blood clots and blood cells [28–30]. The transmission lines and solenoid valves of the purge & trap concentrator were blocked easily with various substances in the blood. Thus, the blocking of instruments was significantly relieved after the cleaning cycle had been conducted for three times.

With the progress of experiment, there would be more and more volatile matter remaining in the instrument. A higher baking temperature and a longer baking time should be set to reduce these residuals. The maximum tolerable temperature of the purge tube is 300 °C, and the maximum operating temperature is supposed to be lower than the tolerable temperature by 20–30 °C.

This method can simultaneously determine the concentration of BTEX in the blood samples. The results are reliable with good separation, required accuracy and precision. The procedure is simple, rapid, accurate and sensitive, which can meet the determination requirements of BTEX concentration in the blood of biological samples.

In conclusion, the method described in present study can simultaneously determine the content of BTEX in human whole blood with P&T-GC–MS. The results are reliable with good separation, required accuracy and precision. The procedure is simple, rapid, accurate and sensitive, which can meet the determination requirements of BTEX content in the blood of biological samples.

Table III
Recovery rate and precision.

Compound	Background value (μg/L)	Addition (0.687 μg/L)		Addition (2.747 μg/L)	
		Recovery rate (%)	RSD (%)	Recovery rate (%)	RSD (%)
Benzene	0.06	83.67	4.02	102.35	5.40
Toluene	0.09	79.21	3.23	95.44	3.93
Ethylbenzene	0.15	85.92	2.77	93.21	4.38
m/p-Xylene	0.12	81.88	3.84	102.07	4.69
o-Xylene	0.08	83.43	4.03	95.13	5.01

Acknowledgments

We thank Shanxi CDC for providing instruments and equipment for this research.

Funding

This work was supported by the Youth Science and Technology Research Fund of Shanxi Province (NO. 201701D221247, 201701D221259), the Science and Technology Innovation Project of Shanxi Higher School (NO. 2017146, 2017147), the Youth Fund of

Shanxi Medical University (NO. 02201604, 02201613), the Startup Foundation for Doctors of Shanxi Medical University (NO. 03201510, 03201521) and the Fund for Shanxi "1331 Project" Key Subjects Construction.

Conflicts of interest

The authors have no conflicts of interest to declare.

Competing economic interests

The authors declare no competing financial interests.

References

[1] S.O. Baek, L.N. Suvarapu, Y.K. Seo, Occurrence and concentrations of toxic VOCs in the ambient air of Gumi, an electronics-industrial city in Korea, Sensors 15 (2015) 19102–19123.
[2] Z. Liu, Y. Liu, G. Zeng, B. Shao, M. Chen, Z. Li, Y. Jiang, Y. Liu, Y. Zhang, H. Zhong, Application of molecular docking for the degradation of organic pollutants in the environmental remediation: a review, Chemosphere 203 (2018) 139–150.
[3] M. Marć, K. Formela, M. Klein, J. Namieśnik, B. Zabiegała, The emissions of monoaromatic hydrocarbons from small polymeric toys placed in chocolate food products, Sci. Total Environ. 530-531 (2015) 290–296.
[4] F.X. Prenafetaboldú, J. Vervoort, J.T.C. Grotenhuis, J.W.v. Groenestijn, Substrate interactions during the biodegradation of benzene, toluene, ethylbenzene, and xylene (BTEX) hydrocarbons by the fungus *Cladophialophora* sp. strain T1, Appl. Environ. Microbiol. 68 (2002) 2660–2665.
[5] S. Fustinoni, F. Rossella, L. Campo, R. Mercadante, P.A. Bertazzi, Urinary BTEX, MTBE and naphthalene as biomarkers to gain environmental exposure profiles of the general population, Sci. Total Environ. 408 (2010) 2840–2849.
[6] A. Aziz, K.S. Kim, Synergistic effect of UV pretreated Fe-ZSM-5 catalysts for heterogeneous catalytic complete oxidation of VOC: a technology development for sustainable use, J. Hazard. Mater. 340 (2017) 351–359.
[7] H. Li, Y. Wang, F. Liu, L. Tong, K. Li, H. Yang, L. Zhang, Volatile organic compounds in stormwater from a community of Beijing, China, Environ. Pollut. 239 (2018) 554–561.
[8] M.A. North, J. Smits, Biomarker sensitivity to vehicle exhaust in experimentally exposed European starlings, Environ. Sci. Technol. 51 (2017) 13427–13435.
[9] N. Brajenović, I.B. Karačonji, A. Bulog, Evaluation of urinary Btex, nicotine, and cotinine as biomarkers of airborne pollutants in nonsmokers and smokers, J. Toxicol. Environ. Health 78 (2015) 1133–1136.
[10] S. Hazrati, R. Rostami, M. Fazlzadeh, BTEX in indoor air of waterpipe cafÃ©s: levels and factors influencing their concentrations, Sci. Total Environ. 524–525 (2015) 347–353.
[11] Y. Yan, L. Peng, N. Cheng, H. Bai, L. Mu, Health risk assessment of toxic VOCs species for the coal fire well drillers, Environ. Sci. Pollut. Res. 22 (2015) 15132–15144.
[12] H. Hajimiragha, U. Ewers, A. Brockhaus, A. Boettger, Levels of benzene and other volatile aromatic compounds in the blood of non-smokers and smokers, Int. Arch. Occup. Environ. Health 61 (1989) 513–518.
[13] L. Liu, S. Hood, Y. Wang, R. Bezverkov, C. Dou, A. Datta, C. Yuan, Direct enzymatic assay for %HbA1c in human whole blood samples, Clin. Biochem. 41 (2008) 576–583.
[14] D. Chambers, C. Reese, L. Thornburg, E. Sanchez, J. Rafson, B. Blount, J. Ruhl, V. De Jesús, Distinguishing petroleum (crude oil and fuel) from smoke exposure within populations based on the relative blood levels of benzene, toluene, ethylbenzene, and xylenes (BTEX), styrene and 2,5-dimethylfuran by pattern recognition using artificial neural networks, Environ. Sci. Technol. 52 (2018) 308–316.
[15] X. Deng, G. Liang, J. Chen, M. Qi, P. Xie, Simultaneous determination of eight common odors in natural water body using automatic purge and trap coupled to gas chromatography with mass spectrometry, J. Chromatogr. A 1218 (2011) 3791–3798.
[16] M.A. Kamal, P. Klein, Estimation of BTEX in groundwater by using gas chromatography-mass spectrometry, Saudi J. Biol. Sci. 17 (2010) 205–208.
[17] M. Meyer-Monath, J. Beaumont, I. Morel, F. Rouget, K. Tack, F. Lestremau, Analysis of BTEX and chlorinated solvents in meconium by headspace-solid-phase microextraction gas chromatography coupled with mass spectrometry, Anal. Bioanal. Chem. 406 (2014) 4481–4490.
[18] N. Negreira, I. Rodríguez, E. Rubí, R. Cela, Optimization of pressurized liquid extraction and purification conditions for gas chromatography-mass spectrometry determination of UV filters in sludge, J. Chromatogr. A 1218 (2011) 211–217.
[19] Y. Rabinowitz, Proposal for adoption of an international method and standard solution for hemoglobinometry, specifications for preparation of the standard solution,and notification of availability of a reference standard solution, Blood 26 (1965) 104–107.
[20] X. Dai, Preparation of creatinine standard stock solution, Anal. Lett. 40 (2007) 2946–2948.
[21] U. Roessner, C. Wagner, J. Kopka, R.N. Trethewey, L. Willmitzer, Technical advance: simultaneous analysis of metabolites in potato tuber by gas chromatography-mass spectrometry, Plant J. 23 (2000) 131–142.
[22] S.K. Padhi, S. Gokhale, Treatment of gaseous volatile organic compounds using a rotating biological filter, Bioresour. Technol. 244 (2017) 270–280.
[23] J.L. Anderson, D.W. Armstrong, Immobilized ionic liquids as high-selectivity/high-temperature/high-stability gas chromatography stationary phases, Anal. Chem. 77 (2005) 6453.
[24] M. Peng, L.M. Vane, S.X. Liu, Recent advances in VOCs removal from water by pervaporation, J. Hazard. Mater. 98 (2003) 69–90.
[25] W.R.A. Jr, M.M. Gray, R.K. Prof, CO_2 adsorption on supported molecular amidine systems on activated carbon, ChemSusChem 3 (2010) 948–956.
[26] J. Wang, C. Yang, H. Li, X. Piao, D. Li, Gas purge-microsyringe extraction: a rapid and exhaustive direct microextraction technique of polycyclic aromatic hydrocarbons from plants, Anal. Chim. Acta 805 (2013) 45–53.
[27] X. Zang, W. Liang, Q. Chang, T. Wu, C. Wang, Z. Wang, Determination of volatile organic compounds in pen inks by a dynamic headspace needle trap device combined with gas chromatography-mass spectrometry, J. Chromatogr. A 1513 (2017) 27–34.
[28] W.O. Thompson, P.K. Thompson, M.E. Dailey, The effect of posture upon the composition and volume of the blood in man, Proc. Natl. Acad. Sci. U. S. A. 5 (1928) 573–604.
[29] S.C.G.N. Braga, L.F. Oliveira, J.C. Hashimoto, M.R.G. Sato, P. Efraim, R.J. Poppi, F. Augusto, Study of volatile profile in cocoa nibs, cocoa liquor and chocolate on production process using GC × GC-QMS, Microchem. J. 141 (2018) 353–361.
[30] A.V. Volzhenin, N.I. Petrova, T.V. Skiba, A.I. Saprykin, Two-stage probe atomization GFAAS for direct determination of trace Cd and Pb in whole bovine blood, Microchem. J. 141 (2018) 210–214.

Invest Clin 60(6): 1517-1529, 2019

The Role of Superoxide Dismutase in Surface Electromyogram (sEMG) Combined with Kneading on Eliminating Fatigue of Athletes

Liangyuan Zhao
Department of physical education, Shanxi Medical University, Taiyuan 030001, Shanxi, China

Jiangong Wang
Department of physical education, Shanxi Medical University, Taiyuan 030001, Shanxi, China

Yaye He*
School of management, Shanxi Medical University, Taiyuan 030001, Shanxi, China
Corresponding Author (E-mail: zly4200@sina.com)

Abstract
Through the analysis technology of surface electromyogram, the effect of superoxide dismutase combined with kneading on eliminating athletes' fatigue was quantified objectively, and the effect of superoxide dismutase combined with kneading on eliminating athletes' fatigue was analyzed effectively. 120 young students of a exercise university were selected as experimental subjects. Three intervention measures were adopted to the subjects: injection of superoxide dismutase, kneading method and combination of superoxide dismutase and kneading method. According to the different intervention measures, the subjects were divided into three groups (A, B and C) and a control group. Each group had 30 experimental subjects. Among them, group A was injected with superoxide dismutase, group B was massaged by kneading, and group C was injection combined with and kneading. Comparing the results of surface electromyogram of biceps brachii and quadriceps femoris in each group, it can be seen that the increase of contraction time of biceps brachii and quadriceps femoris in group C was higher than that in group A and B; the absolute value of median frequency, the absolute value of percentage of change in median frequency, the absolute value of mean power frequency, the absolute value of percentage of change in mean power frequency and the integral EMG values were significantly lower than those in group A and B; and the indicators of biceps brachii and quadriceps femoris in group A, B and C were better than those in control group. It shows that the combination of injection of superoxide dismutase and kneading can effectively eliminate athlete' s exercise fatigue.

Key words: Surface Electromyogram, Combination, Kneading, Athletes, Exercise Fatigue

El Papel de la Superóxido Dismutasa en el Electromiograma de Superficie (sEMG) Combinado con Amasamiento para Eliminar la Fatiga de los Atletas

Resumen
A través de la tecnología de análisis del electromiograma de superficie, se cuantificó objetivamente el efecto de la superóxido dismutasa combinada con el amasamiento para eliminar la fatiga de los atletas, y el efecto de la superóxido dismutasa combinada con el amasamiento en la eliminación de la fatiga de los atletas se analizó de manera efectiva. Se seleccionaron 120 jóvenes estudiantes de una universidad de ejercicio como sujetos experimentales. Se adoptaron tres medidas de intervención para los sujetos: inyección de superóxido dismutasa, método de amasado y combinación de superóxido dismutasa y método de amasado. Según las diferentes medidas de intervención, los sujetos se dividieron en tres grupos (A, B y C) y un grupo de control. Cada grupo tenía 30 sujetos experimentales. Entre ellos, al grupo A se le inyectó superóxido dismutasa, al grupo B se le masajeó amasando, y al grupo C se le inyectó y amasó. Al comparar los resultados del electromiograma de superficie de bíceps braquial y cuádriceps femoral en cada grupo, se puede ver que el aumento del tiempo de contracción del bíceps braquial y cuádriceps femoral en el grupo C fue mayor que en los grupos A y B; El valor absoluto de la frecuencia media, el valor absoluto del porcentaje de cambio en la frecuencia media, el valor

absoluto de la frecuencia de potencia media, el valor absoluto del porcentaje de cambio en la frecuencia de potencia media y los valores EMG integrales fueron significativamente más bajos que los del grupo A y B; y los indicadores de bíceps braquial y cuádriceps femoral en el grupo A, B y C fueron mejores que los del grupo control. Muestra que la combinación de inyección de superóxido dismutasa y amasado puede eliminar efectivamente la fatiga del ejercicio del atleta.

Palabras clave: Electromiograma de Superficie, Combinación, Amasamiento, Atletas, Fatiga por Ejercicio

1. Introduction

Electromyogram (EMG) refers to the muscle bioelectricity graph recorded by electromyography, which is of great significance for evaluating human activities in human-machine system. It is measured by special electromyogram or multi-channel physiological instrument [1]. There are three typical waveforms of electromyogram (EMG) during static muscle work: simple phase, mixed phase and interference phase, which are closely related to muscle load intensity [2]. When the muscles are lightly loaded, isolated single low-amplitude motor unit potentials with a certain interval and a certain frequency appear on the map, i.e. simple phase; when the muscles are moderately loaded, although some areas can still see single motor unit potentials on the map, the potential of other areas is very dense and can not be distinguished, i.e. mixed phase; when the muscles are heavily loaded, there are high amplitude potentials with different frequencies, different amplitudes and overlapping, which are difficult to distinguish, i.e. interference phases. Quantitative analysis of electromyogram is rather complicated and must be completed by computer [3]. Commonly used indicators are integral electromyogram, mean square amplitude, amplitude spectrum, power spectral density function, mean power frequency and median frequency derived from power spectral density function, etc. [4]. Surface electromyogram (sEMG) is an EMG that records the electrical activity of the whole muscle, nerve conduction velocity, spinal cord reflex, muscle involuntary movement and so on.

Superoxide dismutase (SOD) is an important component of antioxidant enzymes in biological system. SOD is widely distributed in microorganisms, plants and animals. SOD is an antioxidant metalloproteinase [5], which can catalyze the disproportionation of superoxide anion radicals to produce oxygen and hydrogen peroxide, and plays an important role in the balance between oxidation and antioxidation and it is inseparable from the occurrence and development of many diseases [6].

Kneading is a traditional Chinese medicine technique and an important one in massage. It is mainly a method to stimulate the muscles or acupoints on the body surface by various manipulations of hands, feet or other instruments, so as to improve the human body' s function, eliminate fatigue and prevent exercise injury[7]. Combining superoxide dismutase (SOD) with traditional kneading method, they will certainly learn from and promote each other. The elimination of exercise fatigue by kneading method can adjust and maintain the good mental state of athletes, increase the potential physical fitness of athletes, and achieve the goal of improving exercise performance [8]. A series of exercise practices at home and abroad show that the kneading method plays a more and more active role in adjusting athletes' competitive status, enhancing and exerting athletes' physical potential and improving athletes' competition performance[9]. In addition, with the development of national fitness campaign, people's exercise consciousness is gradually strengthened, the time of participating in various physical exercises is also increasing, the intensity of exercise is increasing, and physical fitness is improving, but also accompanied by some fatigue and functional damage. Kneading method can be a good solution to these problems [10].

At international conferences, we define exercise-induced fatigue as: the body' s function is beyond its own tolerance, or the body can not maintain the original intensity of exercise. But the difference between exercise fatigue and normal fatigue is that the main cause of exercise fatigue is excessive exercise, which is a normal phenomenon. It is essentially different from what we usually call disease. As long as the proper rest, exercise ability can be restored [11]. But we can' t take it lightly. If the body is in a state of fatigue for a long time, it will cause excessive fatigue, and then cause damage to the body's function. Therefore, eliminating athletic fatigue of athletes is very necessary.

sEMG is a one-dimensional time series signal recorded from the nerve and muscle system activity guided by electrodes on the skin surface. Changes in time and frequency domain characteristics can reflect the functional status of muscle specifically and sensitively, so it is often used to evaluate muscle function. It is widely used in clinical medicine, rehabilitation medicine, ergonomics and exercise science researches [12]. Many studies have found that the signal of sEMG changes significantly when exercise muscle fatigue occurs: the power spectrum curve shifts to the left in varying degrees, and the mean power frequency (MPF) of the frequency domain indicator decreases correspondingly, while the time domain value increases. Mannion et al.

studied the changes of sEMG of lumbar erector muscle during isometric contraction to fatigue. It was found that the median frequency of sEMG decreased with the prolongation of the duration and accorded with the linear model. In addition, at the same load level, the slope of the decline of the median frequency was negatively correlated with the duration of the load. Wang Jian et al. found that under dynamic exercise load, the mean power frequency of EMG signal in the process of lumbar erector muscle fatigue also decreased linearly under dynamic exercise condition [13]. Amplitude-Frequency Joint Analysis (JASA) was a field research technique proposed by Luttmann et al. in 1996. It was a new fatigue measurement method considering both EMG amplitude and spectrum changes. It was considered that in the dynamic analysis of EMG, the increase of amplitude accompanied by the decrease of frequency, suggesting muscle fatigue. In this paper, frequency domain analysis method is used to dynamically analyze the sEMG signal of the main working muscles of the athletes who produce exercise fatigue. The eliminating effect of superoxide dismutase combined with kneading method on athletes' exercise fatigue is detected by the changes of each indicator of sEMG.

2. Materials and Methods

2.1. Research Subjects

120 young athletes aged between 20 and 26 from a exercise training institute of a exercise university were selected as subjects. 120 subjects had no injury history. Their average height and weight were 1.76±0.15m and 70.12±0.58kg), respectively. The basic situation of the subjects was shown in Table 1.

Table 1. Basic information of the subjects

		Number of people/number	percentage/%
age/year	21-22	32	26.7
	23-24	48	40.0
	25-26	40	33.3
Training period/year	0	36	30.0
	≤5	40	33.3
	>5	44	36.7
Maximum strength/kg	≤150	64	54.3
	>150	56	46.7

2.2. Experimental Grouping

The experiment was divided into four groups. 120 subjects were randomly divided into experimental group A (superoxide dismutase injection), experimental group B (kneading method), experimental group C (superoxide dismutase injection combined with kneading method) and control group.

2.3 Methods

Thirty subjects participated in each experiment for one month. During the test period of the experimental group, the subjects required the law of life, rest and movement to ensure the same muscular conditions and reduce the individual differences among the groups [14]. The experimental methods are as follows:

2.4. Experimental Method

Group A: In the experimental period of one month, 0.3% superoxide dismutase (SOD) was injected at 2:00 p.m. every day. The SOD injected was a freeze-dried powder produced by Fujian Huacan Pharmaceutical Co., Ltd.

Group B: The biceps brachii and quadriceps femoris were massaged by professional masseurs at 7:00 p.m. every day for one month.

Kneading methods is composed of press-kneading method and kneading method, which can be divided into two kinds: press-kneading method and palm-kneading method [15]. According to the kneading method, the specific operation is as follows:

1. Press-kneading method: placing the ribbed surface of thumb with one hand or both hands on the operation site. The remaining finger is placed on the opposite side or in a corresponding position to assist. Wrist joint is flexion, thumb and forearm are made active force, then rhythmic press and knead are carried out. Whether it is one-hand thumb kneading or two-hand thumb kneading, its shape is similar to the holding method, the difference is that the holding method is the thumb and the other four fingers on both sides of symmetrical

force, while the press-kneading method is on the thumb side, the remaining finger only plays a role in helping and assisting [16].

2. palm-kneading method: palm-kneading method is divided into single palm kneading method and double palm press kneading method, the operation is quite different.

Single palm kneading is a rhythmic pressing and kneading method with the base of palm focusing on the operation site, the remaining finger stretches naturally, and forearm and upper arm exert active force; double palm kneading principle overlaps the palms, increases strength, and places them in the operation site, with the middle of palm or the base of palm focusing on the shoulder joint as the fulcrum. The upper part of the body moves forward and backward with small rhythm, and the weight of the upper part of the body will be shifted forward when leaning forward. Through shoulder joint and forearm to hand, rhythmic pressing and kneading can be produced [17]. Kneading method is rigid and flexible, comfortable and easy to be accepted. It has the dual function of kneading method, and has a high frequency of clinical application. It is suitable for acupoints on neck, shoulder, medial edge of scapula and all parts of the body. The contact surface of palm kneading method is larger and the kneading force is relatively dispersed. Among them, the single palm kneading method is relatively weak, mostly used in the bladder meridian and lateral line on both sides of shoulder, upper limb and spine; while the double palm kneading method is strong and penetrating, suitable for back, waist and lower limb back [18].

Group C: During the experimental period of one month, 3 ml, 0.3% superoxide dismutase (SOD) was injected at the same time every day, and at the same time, the biceps brachii and quadriceps femoris were massaged by kneading.

Control group: No intervention measures were taken to the subjects.

After a one-month intervention experiment, all the other subjects performed the pedaling and stretching of the lower limbs with the maximum strength of 40%, 60% and 80% at the frequency of 3 seconds/time in sitting posture. Each group of exercises is fatigued so that it can no longer move at a constant frequency. The sEMG of subjects in each group was monitored after exercise.

2.5. Experimental Instruments

The four-channel BL-420E biological function experiment system produced by Chengdu Taimeng Science and Technology Co., Ltd. was used to collect EMG signals of subjects.

YH-1 disposable Ag/AgCl skin surface electrode was produced by Beijing Tianrun Weiye Medical Equipment Factory. The diameter of the electrode was 8 mm, and the center of the two electrodes was 20 mm apart.

The Megawin analysis system of BIOPAD Company in the United States was used to analyze and process the collected EMG images.

2.6. sEMG Signal Analysis Method

sEMG signal is usually analyzed by time-domain analysis method. Time-domain analysis is a relatively simple method of EMG signal analysis, but it can not be used under any circumstances. For example, when muscle contraction force changes, the values of variance, average EMG and integral EMG will change greatly. At this time, EMG signals become unstable, so time domain analysis is no longer used. Therefore, this paper chooses the frequency domain analysis method to analyze the sEMG signal. The frequency domain analysis is to transform the time domain signal into the frequency domain signal by Fourier transform, and to analyze the spectrum or power spectrum of the EMG signal [19]. When muscle contraction force changes, the spectrum or power spectrum changes little, and the frequency domain characteristics obtained by power spectrum are relatively stable. At present, the commonly used frequency domain characteristics of EMG signal are mean power frequency (MPF), median frequency (MF), etc.

The MPF formula of mean power frequency in surface EMG signal is as follows:

$$f_{mean} = \frac{\int_0^{\infty} f \cdot s(f)\,df}{\int_0^{\infty} s(f)\,df} \quad (1)$$

Where, f is the frequency, $s(f)$ is the power spectrum curve, df is the frequency resolution.

The MF formula of the median frequency of sEMG signal is as follows:

$$f_{med} = \int_0^{f_{med}} s(f)df = \int_{f_{med}}^0 s(f)df = 0.5\int_0^\infty s(f)df \quad (2)$$

Mean power frequency and median frequency in frequency domain analysis are commonly used indicators to determine muscle movement.

2.7. EMG Recording

sEMG signal is the same as other bioelectrical signals because of its small signal amplitude and low signal-to-noise ratio. The biggest noise source is 50Hz power frequency interference. In addition, there are electromagnetic radiation interference in the surrounding environment and noise interference in the detection instrument. The whole experiment is carried out in the shielding room. The instrument should also be grounded and away from the strong electrostatic and electromagnetic fields. The room temperature should be 15-25°C.

2.8. Electrode Placement

In order to effectively detect the role of superoxide dismutase (SOD) combined with kneading in eliminating athletes' exercise fatigue, the biceps brachii and quadriceps femoris were selected as the main working muscles of upper limbs and lower limbs. The position of the surface electrodes was the most prominent part of the abdominal muscles.

The biceps brachii muscle: the long head originates from the trochanter above the scapular pelvis, the short head originates from the long coracoid process of the scapula, and the short head converges into the abdomen of the muscles in the middle of the humerus, then descends to the lower end of the humerus, and the integrated tendon ends at the radial trochanter and the fascia of the forearm.

Quadriceps femoris: is in front of thigh muscle.

Before the test, the hair at the place where the electrodes were placed was shaved with a razor. After treating the local skin with alcohol cotton ball, the electrodes with conductive were fixed with tape to prevent the electrodes from sliding or falling off. The ground wire electrode was attached to the upper part of the right ankle joint.

2.9. Experimental Indicators

(1) Muscle contraction time

In the process of isometric static muscle contraction, the longer the muscle fatigue is, the shorter the contraction time is.

(2) Median frequency (MF)

In the process of isometric static muscle contraction, with the development of muscle fatigue, the curve of MF value and time axis decreases linearly. Using the characteristic of linear change, muscle fatigue can be judged.

(3) Percentage of change in median frequency

In the process of isometric static muscle contraction, with the progress of muscle fatigue, the percentage of median frequency change shows a negative slope. The greater the absolute value of the slope is, the greater the tendency of muscle fatigue is.

(4) Mean power frequency (MPF)

In the process of isometric static muscle contraction, with the development of muscle fatigue, the curve of MPF value and time axis decreases linearly. Using its linear change characteristics, muscle fatigue can be judged [20].

(5) Percentage change of mean power frequency

In the process of isometric static muscle contraction, with the progress of muscle fatigue, the percentage change of mean power frequency shows a negative slope. The greater the absolute value of the percentage change is, the greater the tendency of muscle fatigue is.

(6) Integral EMG (IEMG)

Integral electromyogram (IEMG) refers to the total discharges of motor units participating in activities within a certain period of time. That is to say, the value of IEMG reflects to some extent the number of motor units participating in work and the discharges of each motor unit on the premise that time remains unchanged.

All the data were expressed by mean ± standard deviation. Each indicator was studied by SPSS 10.0 statistical software package and the results were carried out multivariate analysis of variance. $P < 0.05$ indicated that there was statistical significance and significant difference. When it is $P < 0.01$, there was significant difference.

3. Results

3.1. Contrast Results of Systolic Duration before and after Intervention

sEMG was used to measure the contraction time of biceps brachii and quadriceps femoris before and after intervention. The results were shown in Tables 2 and 3.

Table 2. Comparison of the contraction time of the biceps muscle of the subject

Group	Number of samples/n	result($\overline{x}$ ±SD)/Sec	
		Before intervention	After intervention
Experimental group A	30	52.641±7.265	64.185±7.618
Experimental group B	30	52.456±6.856	65.471±7.658
Experimental group C	30	52.716±6.439	73.584±8.625
Control group	30	52.593±7.068	58.462±7.158

Table 3. Comparison of the length of contraction of the quadriceps of the subject

Group	Number of samples/n	result($\overline{x}$ ±SD)/Sec	
		Before intervention	After intervention
Experimental group A	30	63.257±8.236	74.582±7.962
Experimental group B	30	62.856±8.035	76.934±7.836
Experimental group C	30	61.862±7.952	79.548±8.025
Control group	30	62.058±8.325	70.258±7.586

In Table 2 and Table 3, the control group was compared with each experimental group and the results had statistical significance, indicating that the control group and the experimental group had significant differences in the results; the comparison of experimental group C and control group, experimental group A and experimental group B had statistical significance, indicating that experimental group C and other groups have significant differences; the comparison results of experimental group A and experimental group B had no statistical significance, indicating that there was no significant difference between experimental group A and experimental group B; the comparison results of experimental group A and control group C had statistical significance, indicating that experimental group A had significant difference with control group and experimental group C; the comparison results of experimental group B had statistical significance with control group and experimental group C, indicating there were significant differences between experimental group B and control group and experimental group C. The longer the contraction time of surface electromyography is, the greater the fatigue of human muscles is. The results of contraction time indicator showed that the contraction time of surface electromyogram of subjects in experimental group C was the longest after intervention, which indicated that the effect of experimental group C on eliminating exercise fatigue of biceps brachii and quadriceps femoris was obviously superior to that of control group A and B. The effect of experimental group A and B on eliminating exercise fatigue of biceps brachii and quadriceps femoris muscles was obviously superior to that of control group. The experimental results showed that superoxide dismutase injection and kneading could effectively increase the contraction time of athletes' surface electromyogram, and there was little difference between the two methods in eliminating athletes' fatigue. Combining superoxide dismutase injection with kneading method, eliminating athletes' exercise fatigue was significantly higher than using single method to eliminate exercise fatigue. After the intervention of superoxide dismutase injection and kneading, the contraction time increased significantly, indicating that the time needed for muscle fatigue increased, the degree of muscle fatigue decreased, and the fatigue state of muscle was eliminated.

3.2. Comparison of Median Frequency before and after Intervention

The median frequencies of biceps brachii and quadriceps femoris were measured by surface electromyography before and after intervention. The results were shown in tables 4 and 5.

Table 4. Comparison of MF values of the biceps of the subject

Group	Number of samples/n	result($\overline{x}$ ±SD)/Hz/min	
		Before intervention	After intervention
Experimental group A	30	-29.584±4.058	-25.684±3.269
Experimental group B	30	-30.547±3.587	-24.685±3.325
Experimental group C	30	-30.259±3.869	-22.158±2.968
Control group	30	-29.964±4.256	-27.685±3.685

Table 6 and Table 7 showed that there were significant differences between the control group and the experimental group, indicating that there were significant differences between the control group and the experimental group. The experimental group C had statistical significance compared with the control group, the experimental group A and the experimental group B, indicating that there were significant differences between the experimental group C and the other groups; the comparison of experimental group A and the experimental group B had significant differences, indicating that there was no significant difference between experimental group A and experimental group B; the comparison of experimental group A and control group C had statistical significance, indicating that experimental group A had significant difference with control group and experimental group C; the comparison of experimental group B with control group and experimental group C had statistical significance, indicating there were significant differences between experimental group B and control group and experimental group C.

The results of the percentage indicator of median frequency change showed that the exercise fatigue of biceps brachii and quadriceps femoris in experimental group C was obviously better than that in control group and experimental group A and B. The exercise fatigue of biceps brachii and quadriceps femoris in experimental group A and B was obviously better than that in control group. From the above experimental results, it can be seen that SOD injection and kneading can effectively eliminate athlete's exercise fatigue, and there is little difference between the two methods. Combining SOD injection with kneading method to eliminate athlete's exercise fatigue is obviously higher than using single method to eliminate athlete's exercise fatigue.

3.4. Comparison of Mean Power Frequency before and after Intervention

The average power frequencies of biceps brachii and quadriceps femoris were measured by sEMG before and after intervention, as shown in tables 8 and 9.

Table 8. Comparison of MPF values of the biceps of the subject

Group	Number of samples/n	result($\overline{x}$ ±SD)/Hz/min	
		Before intervention	After intervention
Experimental group A	30	-32.547±4.622	-26.054±2.985
Experimental group B	30	-32.684±4.204	-25.147±3.158
Experimental group C	30	-31.952±4.052	-23.254±3.058
Control group	30	-32.247±3.954	-28.652±3.321

Table 9. Comparison of MPF values of the quadriceps of the subject

Group	Number of samples/n	result($\overline{x}$ ±SD)/Hz/min	
		Before intervention	After intervention
Experimental group A	30	-42.682±5.471	-30.528±4.765
Experimental group B	30	-45.082±6.025	-29.548±4.952
Experimental group C	30	-44.235±5.815	-27.621±4.158
Control group	30	-43.528±5.628	-35.814±4.528

In Table 8 and Table 9, the control group was compared with each experimental group, and the results had statistical significance, indicating that the control group and experimental group results were significantly different; the comparison of experimental group C with control group, experimental group A with experimental group B had statistical significance, indicating that experimental group C and other groups had significant differences; the comparison of experimental group A with experimental group B had no significant differences, indicating that the difference between experimental group A and experimental group B was not significant. The comparison of experimental group A with control group and experimental group C had statistical significance, indicating that experimental group A had significant difference with control group and experimental group C; the comparison of experimental group B with control group and experimental group C had statistical

significance, indicating there were significant differences between experimental group B and control group and experimental group C.

Mean power frequency is the median of the discharge frequency of muscle fibers during skeletal muscle contraction. By comparing the results of mean power frequency, it could be seen that subjects in experimental group C have significantly better effect on eliminating exercise fatigue of biceps brachii and quadriceps femoris than those in control group, experimental group A and experimental group B. Experimental group A and experimental group B have better effect on eliminating exercise fatigue of biceps brachii and quadriceps femoris. Compared with the control group, the experimental results show that SOD injection and kneading can effectively eliminate athletes' exercise fatigue, and there is little difference between the two methods in eliminating athletes' exercise fatigue. Combining SOD injection with kneading method, eliminating athletes' exercise fatigue is significantly higher than using single method to eliminate athletes' exercise fatigue.

3.5. Comparison of Percentage Change of Mean Power Frequency before and after Intervention

sEMG was used to measure the percentage change of mean power frequency of biceps brachii and quadriceps femoris before and after intervention. The results were shown in table 10 and 11.

Table 10. Percentage change in MF values of the biceps of the subject

Group	Number of samples/n	result($\bar{x}$ ±SD)/%	
		Before intervention	After intervention
Experimental group A	30	-49.582±6.325	-37.965±5.025
Experimental group B	30	-48.628±6.052	-36.685±5.321
Experimental group C	30	-49.125±5.862	-34.582±4.628
Control group	30	-48.952±6.152	-41.652±5.638

Table 11. Percentage change in MF values of the quadriceps of the subject

Group	Number of samples/n	result($\bar{x}$ ±SD)/%	
		Before intervention	After intervention
Experimental group A	30	-55.158±7.258	-43.125±5.915
Experimental group B	30	-56.047±6.852	-42.584±6.058
Experimental group C	30	-55.684±7.351	-39.482±5.689
Control group	30	-55.963±7.512	-47.685±6.584

In Table 10 and Table 11, the control group was compared with each experimental group and the results had statistical significance, indicating that the results of control group and each experimental group were significantly different; the results of experimental group C compared with control group and experimental group A compared with experimental group B had statistical significance, indicating that experimental group C and other groups have significant differences; the comparison of experimental group A with experimental group B had no significant differences, indicating that the difference between experimental group A and experimental group B was not significant. The comparison of experimental group A with control group and experimental group C had statistical significance, indicating that experimental group A had significant difference with control group and experimental group C; the comparison of experimental group B with control group and experimental group C had statistical significance, indicating there were significant differences between experimental group B and control group and experimental group C.

The results of percentage change of mean power frequency show that the exercise fatigue of biceps brachii and quadriceps femoris in experimental group C was obviously better than that in control group and experimental group A and B. The exercise fatigue of biceps brachii and quadriceps femoris in experimental group A and B was obviously better than that in control group. Through the above experimental results, it could be seen that superoxide injection could reduce the exercise fatigue of biceps brachii and quadriceps femoris. Both injection of SOD and kneading can effectively eliminate athlete's exercise fatigue, and there was little

difference between the two methods in eliminating athlete's exercise fatigue. Combining injection of SOD with kneading, eliminating athlete's exercise fatigue is obviously higher than using single method to eliminate athlete's exercise fatigue.

After SOD injection, kneading method and the combination of SOD injection and kneading method, the absolute values of mean power frequency, percentage change of mean power frequency, median frequency change percentage and percentage change of median frequency of the experimental group by using the combination of SOD injection and kneading method were significantly lower than those of the control group. Through the analysis of the above experimental results, it could be seen that the exercise fatigue of biceps brachii and quadriceps femoris was significantly eliminated after the intervention of SOD injection and kneading. In the process of muscle fatigue, the power spectrum of sEMG shifts to low frequency, the proportion of low frequency increases, the proportion of high frequency decreases, the mean power frequency and median frequency of characteristic quantity decrease, and the slope is negative when muscle fatigue occurs. Therefore, the negative slope value of the percentage change of median frequency and the percentage change of mean power frequency are objective indicator to measure local muscle fatigue. Meanwhile, the absolute value of the negative slope of the median frequency, the percentage change of median frequency, the percentage change of mean power frequency and mean power frequency were also less than that of the control group. It showed that after the intervention of SOD injection and kneading, the decrease of mean power frequency and median frequency was inhibited, the degree of muscle fatigue was reduced, and the fatigue state of muscle was eliminated. According to the above experimental results, the combination of SOD injection and kneading could effectively eliminate athletes' muscle fatigue. The mechanism of exercise-induced muscle fatigue was extremely complex. Many physiological processes, such as central motor drive, excitation-contraction coupling of neuromuscular junction and muscle energy metabolism, were designed. There were causal relationships between the formation and change of sEMG signal characteristics and the physiological processes related to fatigue. SOD and kneading can eliminate exercise-induced fatigue of muscles.

3.6. Comparison of Percentage Change of IEMG before and after Intervention

sEMG was used to measure the IEMG values of biceps brachii and quadriceps femoris before and after intervention. The results were shown in Table 12 and 13.

Table 12 Comparison of IEMG values of the biceps of the subject

Group	Number of samples/n	result($\bar{x}$ ±SD)/Hz/min	
		Before intervention	After intervention
Experimental group A	30	0.566±0.053	1.189±0.086
Experimental group B	30	0.605±0.065	1.158±0.105
Experimental group C	30	0.596±0.075	0.952±0.098
Control group	30	0.638±0.077	1.385±0.135

Table13. Comparison of IEMG values of the quadriceps of the subject

Group	Number of samples/n	result($\bar{x}$ ±SD)/Hz/min	
		Before intervention	After intervention
Experimental group A	30	0.835±0.105	1.286±0.103
Experimental group B	30	0.865±0.126	1.308±0.095
Experimental group C	30	0.887±0.096	1.125±0.108
Control group	30	0.806±0.075	1.526±0.152

In Table 12 and Table 13, the comparison of control group with the each experimental group had statistical significance, indicating that the results of control group and each experimental group are significantly different; the comparison of experimental group C with control group, experimental group A with experimental group B had statistical significance, indicating that experimental group C and other groups have significant differences; the comparison of experimental group A with experimental group B had significant differences, indicating that experimental group A and experimental group B had no significant differences. The comparison of experimental group A with control group and experimental group C had statistical significance, indicating that experimental

group A had significant difference with control group and experimental group C; the comparison of experimental group B with control group and experimental group C had statistical significance, indicating there were significant differences between experimental group B and control group and experimental group C.

IEMG of subjects in each group increases continuously with the increase of fatigue, which was consistent with previous research results. Therefore, the IEMG of sEMG was selected as an important indicator to evaluate athletes' exercise fatigue. The IEMG value of measured muscle was significantly increased under vigorous exercise, while that of control group was larger, and that of experimental group C was smaller. By comparing the results of IEMG values, it could be seen that subjects in experimental group C had significantly better effect on eliminating exercise fatigue of biceps brachii and quadriceps femoris than those in control group, experimental group A and experimental group B, and that in experimental group A and B, the effect of eliminating exercise fatigue of biceps brachii and quadriceps femoris was obviously better than that in control group. Through the above experimental results, it could be seen that injection of SOD and kneading can effectively eliminate athletes' exercise fatigue, and the effect of using the two methods to eliminate athletes' exercise fatigue was not much different. Combining injection of SOD and massage method, eliminating athletes' exercise fatigue was significantly higher than that using a single method to eliminate exercise fatigue.

Through the above experimental results, it could be seen that there was no statistical significance in each indicator of the experimental results of SOD injection and kneading method. It showed that injection of SOD and kneading method had no significant difference in eliminating athletes' exercise fatigue of biceps brachii and quadriceps femoris. The main reason was that injection of SOD and kneading method could effectively eliminate the exercise fatigue of athletes with specific purpose, which produced close physiological effects. Therefore, there was no significant difference in statistical results between the two methods.

The above experimental results showed that the SOD injection and kneading could effectively eliminate athletic fatigue, and there was no significant difference between the two methods in eliminating athletic fatigue. Combining the two methods, the degree of eliminating athletic fatigue was obviously improved, which could achieve twice the result with half the effort.

4. Discussion

High-intensity exercise can lead to cell and tissue damage and changes in the structure of some biological macromolecules, increase the production of free radicals, thereby causing tissue damage and fatigue. There is an enzymatic system against free radicals in the human body. SOD can accelerate the elimination of free radicals in the body, so that the body can recover as soon as possible and reduce damage. Exercise-induced fatigue includes several basic processes: the accumulation of fatigue products of metabolic matrix (accumulation hypothesis); the depletion of matrix required for exercise (exhaustion hypothesis); the change of physiological and chemical state of matrix; and the disorder of regulation and coordination of organism. The mechanism of exercise-induced fatigue can be divided into two aspects. One is the fatigue chain. The decline of muscle's working ability is the manifestation of fatigue. In this process, there are a series of links which can cause fatigue from brain to muscle. With the development of research on exercise-induced fatigue in recent years, the fatigue chain of nerve-hormone and metabolic-immune regulatory network can be listed. The second is catastrophe theory: because exercise fatigue is a synthesis of many factors, the changes of one or several factors at the same time will interact, leading to fatigue. So catastrophe theory combines intracellular energy consumption, muscle strength decline, muscle excitability and activity changes during exercise. When these factors change to a certain extent, in order to protect the body from exhaustion, the form of fatigue is shown.

Exercise can make a great change in body metabolism, especially the consumption of oxygen changes with the change of exercise time and intensity, and the production of free radicals also changes accordingly. Studies have shown that oxygen free radicals are related to the formation of exercise fatigue and injury. Skeletal muscle is a motor organ. As exercise increases its energy consumption, local oxygen consumption and mitochondrial load of muscle cells, it produces a large number of free radicals. Oxygen free radicals consume a large amount of SOD, increase the loss of antioxidant enzyme system, break the balance between free radicals production and elimination, and a large amount of lipid peroxide can directly damage the normal structure of muscle cell membrane and reduce its contractile and diastolic ability. Mitochondrial dysfunction is caused by cell lysis, which leads to fatigue or injury. The production of free radicals is related to exercise. Exercise can also improve the body's many metabolic functions, improve the body's adaptability, enhance the motor function, and the oxidase system against free radicals is no exception. SOD is the only enzyme based on oxygen free radicals. Oxygen free radicals are mainly produced in the process of water formation from mitochondrial oxygen consumption. Therefore, it is speculated that there may be a relationship between SOD activity and oxygen capacity. The activity of SOD in serum increases with the increase of aerobic capacity, which is conducive to scavenging a large number of oxygen free radicals produced by mitochondria during aerobic process. It can be

inferred that the activity of SOD can reflect the aerobic metabolic ability of athletes to a certain extent, as an important reference indicator to measure the aerobic ability. The production of free radicals is closely related to exercise training, fatigue injury and recovery mechanism. The kneading method is a traditional massage method in China. In exercise training, the combination of injection of SOD and kneading method can effectively improve the activity of anti-free radicals enzymes system and athletes' aerobic metabolism ability, quickly eliminate free radicals generated in the body, and has important practical significance to improve exercise ability and eliminate exercise fatigue and injury.

5. Conclusions

The decrease of free radical level and the improvement of anti-free radical ability in vivo can prevent the damage of free radical to the structure and function of cells in vivo, which has positive significance in eliminating exercise fatigue and improving exercise ability. Functional recovery after training is a very important part of exercise training. It is of great and far-reaching significance to improve the effect of exercise training by using scientific, convenient, effective and non-toxic means of recovery after exercise training. sEMG was used to monitor the body condition of athletes after intense exercise, and the effect of SOD combined with kneading on athletes' fatigue was detected. The experimental results showed that the combination of SOD and kneading method could effectively increase the contraction time of athletes' muscles, reduce the mean power frequency, the percentage change of mean power frequency, the median frequency, the percentage change of the median frequency and the IEMG value of athletes' sEMG after exercise, and verify the role of combination of SOD and kneading method on eliminating athletes' exercise fatigue.

Acknowledgements

Shanxi Medical University 2014 Science and Technology Innovation Fund Project. [2014] 29

Reference

[1] Li, L. M., Liu, M.H. （2017"Research on the Robustness of Face Recognition Based on Machine Learning Algorithms", *Journal of China Academy of Electronics and Information Technology*, 12(2), pp.113-118.
[2] Zhao, M. Z., He, J.P., Zheng, B. (2017)"Model and Prediction of CM Conducted Emission Cumulative Effects in Parallel-inverter Generation System",*Journal of Power Supply* ,15(3),pp.9-17.
[3] Zhang, Y.K., Su, L.S., Wang, C.J. (2018) "Aging Models of Lithium-ion Batteries under Multiple Factors", *Chinese Journal of Power Sources*, 42(1), pp.32-36.
[4] Qu,J. J. (2017)"The Role of Electronic Medical Records in Hospital Information Management and Related Issues", *Automation & Instrumentation*, 2017(6),pp.226-227.
[5] Sun, J.J., Zhao, Y., Wang, S.G. (2018) "Improvement of SIFT Feature Matching Algorithm Based on Image Gradient Information Enhancement", *Journal of Jilin University (Science Edition)*, 56(1), pp.82-88.
[6] Teng, J.Y., Xu, H.B., Wang, Y. (2017) "Design and Simulation of Motion Trajectory Planning for Manipulator of Picking Robot", *Computer Simulation*, 34(4), pp.362-367.
[7] Gazzoni,M., Botter, A., Vieira, T. (2017)" Surface EMG and Muscle Fatigue: Multi-channel approaches to the study of Myoelectric Manifestations of Muscle Fatigue", *Physiological Measurement*, 38(5), pp.R27-R60.
[8] Beretta-Piccoli, M., D'Antona, G., Zampella, C. (2017) "Test-retest reliability of Muscle Fiber Conduction Velocity and Fractal Dimension of Surface EMG During Isometric Contractions", *Physiological Measurement*, 38(4), pp.616-630.
[9] Ayers, J. I., Mcmahon, B., Gill, S. (2017) "Relationship Between Mutant Cu/Zn Superoxide Dismutase 1 maturation and Inclusion Formation in cell Models", *Journal of Neurochemistry* ,140(1), pp.140-150.
[10] Tan, S. X., Teo, M., Lam, Y. T. (2018) "Cu, Zn Superoxide Dismutase and NADP(H) Homeostasis are Required for Tolerance of Endoplasmic Reticulum Stress in Saccharomyces Cerevisiae", *Molecular Biology of the Cell*, 20(5), pp.1493-1508.
[11] Azarabadi, S., Abdollahi, H., Torabi, M. (2017)"ROS Generation, Oxidative Burst and Dynamic Expression Profiles of ROS-scavenging Enzymes of Superoxide Dismutase (SOD), Catalase (CAT) and Ascorbate Peroxidase (APX) in Response to Erwinia amylovora in Pear (Pyrus communis L)", *European Journal of Plant Pathology*,147(2), pp.279-294.
[12] Lintuluoto, M., Yamada, C., Juha, M. (2017)"Lintuluoto. QM/MM Calculation of the Enzyme Catalytic Cycle Mechanism for Copper- and Zinc-Containing Superoxide Dismutase", *Journal of Physical Chemistry B* ,121(30), pp.7235-7246.

[13] Škiljić, D., Petersen, A., Karlsson, J. O. (2018) "Effects of 17β-Estradiol on Activity, Gene and Protein Expression of Superoxide Dismutases in Primary Cultured Human Lens Epithelial Cells", *Current Eye Research* ,43(91), pp.639-646.

[14] Clark, I. E., Goulding, R. P., Dimenna, F. J. (2018) "Time-trial Performance is not Impaired in Either Competitive Athletes or Untrained Individuals Following a Prolonged Cognitive Task", *European Journal of Applied Physiology* ,119(1), pp.149-161.

[15] Mendonça, L., Natália, B., Davidson, S. (2017) "The Frontal Plane knee projection angle in elite male volleyball athletes is increased after an incremental shuttle run test until voluntary fatigue", *British Journal of Exercise Medicine*, 51(4), pp.362.2-363.

[16] Edouard, P., Gimenez, P., Arnal, P. (2017) "Effect of Fatigue on Muscle Function in Repeated Spinal Exercise", *British Journal of Exercise Medicine*, 51(4), pp.314.2-314.

[17] Mrazik, M., Lenchyshyn, J., Borza, C. (2017) "Reliability of the Scat2/3 in College Athletes", *British Journal of Exercise Medicine*, 51(11), pp. A76.2-A76.

[18] Nelson, M. J., Bellenger, C. R., Thomson, R. L. (2017) "Maximal Rate of Heart Rate Increase Correlates with Fatigue/recovery Status in Female Cyclists", *European Journal of Applied Physiology*, 117(10), pp.1-7.

[19] Tavares, F., Smith, T. B., Driller, M. (2017) "Fatigue and Recovery in Rugby: A Review", *Exercise Medicine*, 47(8), pp.1515-1530.

[20] Yan, B., Liu, Y., Shi, A. (2017) "Investigation of the Antifatigue Effects of Korean Ginseng on Professional Athletes by Gas Chromatography-Time-of-Flight-Mass Spectrometry-Based Metabolomics", *Journal of Aoac International*, 101(3), pp.701-707.

青少年體育

2017
9 总第53期

国内统一刊号：CN 10-1081/G8　　国际统一刊号：ISSN 2095-4581

励志奋进 奔竞不息——中华人民共和国第十三届学生运动会在杭州举行

- 大数据时代学校体育改革的思考
- 大学健美操教学中核心力量训练应用研究
- 休闲视角下撕名牌活动进入高职田径课的可行性研究
- 游泳运动干预对7～10岁儿童注意力的影响

图片说明：中华人民共和国第十三届学生运动会开幕剪影

ISSN 2095-4581

◎ 主管单位：国家体育总局
◎ 主办单位：北京体育大学

中图分类号：G843 文献标识码：A 文章编号：1674-151X（2017）09-056-03

分析中英青少年足球训练差异及训练理念比较

杜旭峰
（山西医科大学，山西 太原 030001）

欧美地区足球水平较高，纵观英美两国足球发展进程，可知其青少年足球选手的培养、队伍建设等方面较为全面。因此，研究其青少年足球训练过程及理念对提高我国足球水平有着很大的作用。本文通过对比中国与英国青少年足球训练差异，比较训练理念的偏差，旨在为提高我国足球水平提供理论参考。

1 中英青少年足球训练差异

1.1 训练目标不同

足球训练是一个长期且系统的过程，青少年具有其自身成长规律，需要进行有目的的训练，才可有效提高青少年足球能力。以利物浦青少年足球训练计划为例，可以看出英国对青少年自身发展与成长过程进行清晰地分类，并制订出多年训练计划，实施有的放矢的训练过程。其主要将青少年成长过程分为五个阶段，在此基础上设计三个层次训练目标，并根据接受训练的青少年球员身心特点，加入针对性的任务，体现出明显的年龄特点。首先将球员7～13岁定为基础训练阶段，在7～11岁时，主要培养球员对足球的兴趣，并对足球有所了解。在11～13岁时，要求球员可以掌握基本足球技术；而在球员年龄位于13～15岁时，是中级训练阶段，要求其可以熟练掌握各类足球技术，并逐渐提高其对抗能力；在球员年龄在15～19岁时，则进入高级训练阶段，主要培养球员竞技能力。由此可见英国训练具有年龄特征较为鲜明的针对性，课程连续紧凑，目标明显，且循序渐进，符合青少年学习特点。

我国在进行青少年足球训练时，虽然教练对青少年的年龄特点有所掌握，并接受过专业的学习，但教学过程往往偏离了青少年成长规律，这与我国训练过程未指定多年专业培养目标有着很大的关系，且急功近利的思想影响着教练的判断，从而导致其不按照青少年成长规律教学，违反足球运动的规律性训练。此外，追溯至20世纪50年代，查看我国足球发展进程，皆以最终成绩作为训练目标，从而导致足球运动逐渐萎缩，学习足球的青少年也逐年减少。且由于教学目标的片面性与功利性，而忽视了青少年青少年成长的系统性，因此错过了青少年成长过程的敏感期，中国足球健康发展的环境因此缺失，足球水平提升空间较小。

1.2 训练要素不同

训练要素亦是中英两国足球训练过程中的明显差异之一。依然以利物浦青少年足球训练计划为例，可知英国球队每周训练8课次，平均时间为80～90分钟，基本理论练习密度约为60%，基本部分练习形式平均变化4～6类，形式训练平均时间为10～15分钟，平均训练频率为150～170次。而我国球队每周训练10课次，平均时间为120～150分钟，基本理论练习密度约为90%，基本部分练习形式平均变化2～3类，形式训练平均时间为20～30分钟，平均训练频率为130～150次。通过上述训练要素设置不难看出英国球队训练周课次、课程实践、练习密度、练习形式皆较少，而其他方面较高。对此英国足球教练给出了解释，此种训练方法虽训练量较少，但注重训练质量，运动员尤其是青少年能够集中注意力，充满激情的训练，且做到劳逸结合。而我国训练进程被英国教练评论为“跑圈式”训练，训练量大，效果却无法有效提升。

1.3 课程结构不同

通过对比中英足球训练过程，不难看出二者课程结构存在很大的差异。将利物浦训练过程作为英国足球训练的代表，可以看出其在设计课程时严格按照青少年年龄特点及成长规律进行。训练阶段大多取自青少年球员9～19岁这10年，且各年龄阶段的课程内容一般分为五个部分，前两部分为一个课程阶段，后两部分为一个课程阶段。三个阶段组成一节训练课时。通常第一阶段引导球员集中注意力、提高其反应力等，第二阶段通常以技术训练为主，第三阶段则以小范围比赛作为实战练习。且其每节课皆有一个主题，并严格按照此主题进行训练、巩固，训练形式变化多样，不仅提高球员联系兴趣，亦可发散其思维，提高创新能力。此外，课程设置中的热身、放松等因素皆与我国有所差异，其在热身时多利用足球，在放松休息时注重全身心放松。

我国在进行青少年足球训练时，教练大多利用同一的教学大纲进行训练，每节课时具有目的性，训练量较大，理论与实践并存。训练大概分为三个步骤：热身、理论讲解、训练。但在训练时会出现知识结构重复的现象，且部分

投稿日期：2017-07-14
作者简介：杜旭峰（1981～），讲师，硕士。研究方向：青少年足球训练方法。

训练内容不符合运动规律，导致我国足球运动水平停滞不前。

1.4 课程组织形式不同

英国青少年足球训练课程组织形式多样，可有效提高球员对于训练的兴趣，而兴趣是其关注事物、努力训练的动机与动力。因此英国在训练时会选择在13岁前利用竞赛、游戏的方法进行训练，而在其他年龄段的青少年尽管游戏竞赛活动较少，但课堂训练的气氛却较为轻松，使得青少年在快乐中进行训练，不仅是教练对球员的尊重，亦是其对球员的鼓励。此外，英国在训练过程中还会不断变化形式与要求，用多样化的训练过程引导球员训练。

我国的足球训练形式大多较为单一，且具有较长的重复时间，因此会使球员在训练时逐渐失去兴趣，失去对足球的练习激情。这与我国的训练结构与教练的知识结构有着很大的关系，其大多按照教科书或以往的教学经验进行训练，而教科书上大多讲解原则，而很少介绍足球的训练方法。

1.5 对足球训练的理解不同

对足球的理解是足球训练的根本，而我国与英国对足球的理解也存在着较大的偏差。首先，英国方认为足球训练是思维能力训练，而我国注重技巧的训练。通过世界杯决赛不难看出，足球运动的优势在于整体性对抗，整体性对抗的决定因素是球员的思维能力。而我国足球训练与其有所偏差，导致能力无法提升。其次，英国足球训练着重培养球员对足球的兴趣，而我国过于注重球员对球技的模仿性训练与重复性训练，在一定程度上制约着球员的思想空间与思维能力。兴趣是球员发散性思维的重点，亦是其关注新鲜事物的开始。观察我国球员，在踢球时动作生硬、配合牵强，且球员兴趣泛泛，创造性低。此外，英国青少年足球训练利用有干扰的局部比赛进行训练，让球员提早感受足球比赛的过程与特点，从而适应足球比赛的氛围。而我国在足球训练时只注重单一的技能、行为训练，即使拥有优秀的基本能力，但在球场上比赛时往往会出现低应变能力的现象。

2 中英青少年足球训练理念比较

2.1 战略性理念

战略性训练理念是训练的全面把握，具有可持续性。其在青少年培养过程中，不仅发掘青少年的经济能力，亦加强青少年文化教育，从而促进青少年全面发展。足球运动是一项受到青少年喜爱的运动项目，全面发展的知识水平可进一步提升青少年球员的训练能力。对比我国青少年足球训练理念，英国在选材上较为看重球员本身的特点，并根据其年龄层次因材施教，从而对球员本身的特点与性格予以保留，并着重培养其足球总体战略思想与足球竞技意识。其在青少年足球训练中加入文化知识，促进体育与文化的有机结合，并因此保留球员的创造能力。英国足协的官员提出，青少年足球训练中的球员首要任务为学习。对于部分天赋较高的球员，会用专业的教练对其进行有计划且长期的教学与指导。

我国青少年足球训练所遵循的战略性理念主要为竞赛等活动进行循环、周期的训练，并将最终成绩作为目的，因此会提前为国家球队选取球员，并将青少年球员进行集中管理。在很大程度上对其他球员有所忽视，减少了我国优秀足球运动员的储备量。集中性处理未将球员的年龄层进行区分，亦不利于我国足球运动的持续发展。此外，在成绩为目标的战略性理念中，教练大多选取体能优秀的球员进行训练，因此忽视了足球运动的灵敏性、配合性的特点。高强度的训练对青少年身体承受力有着较高的要求，还在一定程度上影响着其健康成长。

2.2 操作性理念

操作性理念以足球本质为基础，要求球员对足球有着较为深刻的认识。因此要求教练在设计训练过程与制定训练计划时，要对足球的本质充分理解，并因此安排训练内容。且足球运动的速度性、灵敏性、全局性、对抗性特征较为明显，在训练过程中亦需要对此类特点进行针对性研究与设计。英国操作性训练理念遵循球员对训练以及需求的热情，并将兴趣作为训练成功的基础与保障。且其认为训练的目的不是简单的模仿技巧以及枯燥的身体训练，而是激发出球员对足球的深入理解，并提高其训练兴趣，从而有效引导青少年了解足球的本质并感受足球的魅力。在英国教练眼中，成绩不是训练的最终目标，体验的过程才是训练的重点。因此要求教练具有对足球的热情，并具有高标准的足球素养。为了选拔优秀的足球教练，亦会对教练进行严格的考核。

而我国操作性训练理念不具备规范的科学体系，且教练在训练时针对性较低，大多笼统地进行体能训练，而忽视了球员自身的特点。由此可见，部分教练的训练随意性较大，训练计划不够完善甚至是缺失。久而久之，球员会对足球渐渐失去个性化的特点。此外，我国操作性训练理念大多以教练作为训练的中心，对球员的训练内容有着硬性的规定，导致球员在训练时盲目听从，没有对足球运动有着深刻的理解，更不会产生自己的看法。尤其是青少年，其对足球本身的理解较为浅显，教练应该作为引导者加强其训练部署能力，并适当监督，将学生作为训练的主体。

2.3 评价性理念

评价性理念是在足球训练与比赛的过程中，教练对球员的评价以及球员对自身的评价，隶属于教育心理学范畴。而此种训练理念的形成与心理学、运动学共同发展与结合有着紧密的联系。优秀的评价性理念对青少年球员的训练有着强大的引导与鼓励作用，因此要求教练选取正确的时间与场合，对青少年进行评价与指导，用正确的方法对其批评与赞赏，从而有效提升其训练成果。可以说评价性理念是足球生涯中十分重要的原则理念之一，正确利用可以有效激发出球员的自信心以及训练的动力。英国青少年足球专家提出青少年的个性是足球运动的重点要求，因此在训练过程中要加入鼓励的因素，从而有效提高球员的自信心。而过多的批评将会使其逐渐失去自信，最终丧失对足球运动的想象力。因此英国在进行青少年足球训练时会利用正确的评价对球员进

（下转第112页）

的前提下，正确数存在显著性差异（P=0.006<0.05），干预3～4年儿童的注意力成绩明显好于干预1～2年儿童的注意力成绩(196.428 6>132.058 8)。

游泳这项运动需要全身肌肉协同发力，并且配合呼吸进行，动作难度较高，在学习动作过程中和运动中，都要求有较高的注意力，同时也会在日常的学习和运动中促使注意力得到提高。所以，两组儿童注意力存在显著性差异。

在平均反应时上两组儿童没有显著性差异(P=0.804>0.05)，但是干预1～2年儿童的平均反应时比干预3～4年儿童的平均反应时差（0.974 7>0.925 7）。笔者猜想，由于时间、经费等条件的限制，测得的数据量较少，因此在平均反应时上两组儿童之间没有出现显著性差异。

2.2 不同性别儿童注意力的对比分析

将测试的数据使用独立样本t检验，得到表2。从表2中可以得出，不同性别在年龄（P=0.760>0.05）和游泳运动干预时长（P=0.302>0.05）没有差异的前提下，正确数存在显著性差异（P=0.010<0.05），且女生的注意力显著高于男生的注意力（195.500 0>181.714 3）。在平均反应时上，男、女生不存在显著性差异(P=0.525>0.05)，但是女生的平均反应时明显高于男性的平均反应时（0.914 0>0.993 6）。由于性别上的差异，男、女生在生理、心理方面存在不同，经测试得出在注意力方面也存在不同。

表1 不同干预时间对儿童注意力的差异性比较

	组别	N	均值	标准差	均值的标准误	F	P
正确数	干预1～2	17	132.058 8	85.087 80	20.636 82	9.309	0.006
	干预3～4	7	196.428 6	28.779 95	10.877 80	–	–
平均反应时	干预1～2	17	0.974 7	0.101 00	0.024 50	0.063	0.804
	干预3～4	7	0.925 7	0.116 31	0.043 96	–	–
性别	干预1～2	17	1.294 1	0.469 67	0.113 91	0.006	0.937
	干预3～4	7	1.714 3	0.487 95	0.184 43	–	–
年龄	干预1～2	17	8.235 3	0.831 37	0.201 64	0.720	0.405
	干预3～4	7	8.714 3	0.487 95	0.184 43	–	–

表2 不同性别儿童注意力的独立样本t检验

	性别	N	均值	标准差	均值的标准误	F	P
年龄	男	14	8.285 7	0.825 42	0.220 60	0.095	0.760
	女	10	8.500 0	0.707 11	0.223 61	–	–
正确数	男	14	181.714 3	18.184 65	4.860 05	8.016	0.010
	女	10	195.500 0	33.337 50	10.542 24	–	–
平均反应时	男	14	0.993 6	0.105 87	0.028 30	0.417	0.525
	女	10	0.914 0	0.090 46	0.028 60	–	–
游泳运动干预时长	男	14	1.892 9	0.944 18	0.252 34	1.118	0.302
	女	10	2.700 0	1.059 35	0.335 00	–	–

3 结论与建议

3.1 结 论

男、女生在注意力方面存在显著性差异，女生好于男生；游泳运动干预对注意力的提高有积极的影响。

3.2 建 议

处于儿童期的男、女生要关注注意力的发展，男生应特别注意；对于处于注意力发展敏感期的儿童，应进行游泳运动干预，且干预时间越长越好。

参考文献：

[1] 伍天花．学生体质下降与学校体育目标达成的辩证思考[J]．体育与科学，2010（4）．
[2] 李启迪，邵伟德．体育教学基本理论研究[M]．北京：北京师范大学出版社，2014.
[3] 曲宗湖，马保生．我国学校体育必须“转型”[J]．中国学校体育，2014(1)．
[4] 孔久春．体育锻炼方式对儿童注意力稳定性的影响[J]．中国学校卫生，2012（4）．

（上接第57页）

行鼓励，使其养成享受比赛的习惯，不对输赢有着过多的关注。

目前，我国的评价训练理念大多着眼于比赛、活动的结果，并过多强调获胜，因而在青少年足球知识的教育与训练过程中形成错误的认知，导致青少年球员的心态逐渐失衡，对比赛的输赢看得过重。当其遇到较为强大的对手时，将会失去自信，无法专注于比赛。

3 结 语

通过对中英青少年足球训练差异及其训练理念进行对比，不难发现我国训练方法较英国来说存在着一定的差距。我国足球水平的提高需要从本质入手，借鉴英国成功经验，并合理引进其训练理念，从而创新青少年足球训练思路，将理论与实践有机结合，注重球员全面发展，最终有效提高我国足球水平。

参考文献：

[1] 王炜华．中外足球青少年训练理念的比较分析[J]．运动，2010（6）．
[2] 曹玥，尹子昕．中外青少年足球训练理念对比分析[J]．科技展望，2015（31）．
[3] 王剑．中英足球青少年训练理念、方法的比较[J]．科技信息：学术研究，2008（9）．

山西医科大学四年制运动康复专业教学进程表

序号	课程类别	课程名称	授课学期及考试形式		学分			学时数				第一学年		第二学年		第三学年		第四学年	
			考试	考查	总学分	理论	实验实践	总学时数	理论	实验实践	线上学习	1	2	3	4	5	6	7	8
												15周	18周	18周	18周	18周	18周	20周	20周
1	通识课程	军事理论	1		2	2		36	18		18	36						专业实习及毕业实习四十周	
2		大学英语	234	1	12	12		192	192			48	48	48	48				
3		大学计算机	1		2	1.5	0.5	48	24	24		48							
4		人工智能导论	3		1.5	1.5		24	24					24					
5		高等数学	1		3	3		48	48			48							
6	医德与人文教育课程	思想道德修养与法律基础	1		2.5	2.5		44	44			44							
7		中国近现代史纲要	2		2.5	2.5		48	48				48						
8		马克思主义基本原理概论	3		2.5	2.5		48	48					48					
9		毛泽东思想和中国特色社会主义理论体系概论	4		4.5	4.5		72	72						72				
10		形势与政策		1-7	2	2		56	48		8	8	8	8	8	8	8		
11		思想政治理论实践课		1-4	2		2	54		54		12	12	14	16				
12		医学伦理学		6	1	1		20	20								20		
13	专业基础课程	运动解剖学	1		5.5	4.5	1	108	72	36		108							
14		细胞生物学		1	1.5	1.5		24	24			24							
15		心理学	2		2	2		36	32	4			36						
16		运动生物化学	2		1.5	1.5		30	30				30						
17		运动生理学	2		4	3.5	0.5	80	60	20			80						
18		运动训练学	3		3.5	3.5		58	58					58					
19		人体发育学	3		2	2		32	32					32					
20		运动营养学	3		2	2		36	36					36					
21		病理学	3		1.5	1.5		26	26					26					
22		医学影像学	4		3	2.5	0.5	60	40	20					60				
23		药理学		4	2	2		32	32						32				
24		运动生物力学	4		2	2		36	36						36				
25		诊断学	4		3.5	3	0.5	72	54	18					72				
26		内科学基础	5		2	1.5	0.5	36	24	12						36			
27		外科学基础	5		2	1.5	0.5	36	24	12						36			
28		中医基础理论	5		2	2		36	36							36			
29		大学生创新能力与创业基础		2	1	1		16	16				16						
30		医学信息检索与利用		5	1	0.5	0.5	22	10	12						22			
31	专业核心课程	田径	1		1.5	1	0.5	36	18	18		36							
32		体操	1		1.5	1	0.5	36	18	18		36							
33		篮球	1		1.5	1	0.5	36	18	18		36							
34		排球	2		1.5	1	0.5	36	18	18			36						
35		武术	2		1.5	1	0.5	36	18	18			36						
36		体育概论	2		2	2		36	36				36						
37		足球	4		1.5	1	0.5	36	18	18				36					
38		体育舞蹈	3		1.5	1	0.5	36	18	18				36					
39		小球运动(乒乓球、羽毛球)	3.3		3	2	1	72	36	36				36	36				
40		健美操	4		1.5	1	0.5	36	18	18					36				
41		专业英语	4		1	1		18	18						18				
42		游泳运动	5		1.5	1	0.5	36	18	18						36			
43		医务监督	5		1.5	1.5		36	28	8						36			
44		康复功能评定学	5		4	3.5	0.5	80	62	18						80			
45		肌肉骨骼康复学	5		2.5	2	0.5	54	36	18						54			
46		运动急救		5	1	0.5	0.5	18	8	10						18			
47		贴扎术		5	1	0.5	0.5	18	9	9							18		
48		运动处方	6		2.5	2	0.5	54	36	18							54		

序号	课程类别	课程名称	授课学期及考试形式		学分			学时数				第一学年		第二学年		第三学年		第四学年	
			考试	考查	总学分	理论	实验实践	总学时数	理论	实验实践	线上学习	1	2	3	4	5	6	7	8
												15 周	18 周	18 周	18 周	18 周	18 周	20 周	20 周
49		跆拳道	6		1.5	1	0.5	36	18	18							36		
50		针灸学		6	3.5	3	0.5	72	48	24							72		
51		体育统计学		6	1.5	1.5		36	28	8							36		
52		物理治疗学	6		2.5	2	0.5	54	36	18							54		
53		运动损伤康复	6		2.5	2	0.5	54	36	18							54		
54		运动疗法技术学	6		2.5	2	0.5	54	36	18							54		
55		康复心理学		6	2	2		36	32	4							36		
56		拉伸术		6	1	0.5	0.5	18	2	16							18		
57		中医养生康复		6	1	1		18	12	6							18		
58		推拿与按摩		6	1	0.5	0.5	36	8	28							36		
课程合计		开设总门次、学时数	46	25	131.5	113.5	18	2590	1915	649	26	484	386	402	434	362	514	8	
		每学期开设总门数										12	11	12	10	10	14	1	
		考试门数										8	8	10	8	7	5	0	
		考查门数										4	3	2	3	3	9	1	
		周学时										32.3	21.4	22.3	24.1	20.1	28.6	0.4	
1	实践环节(周)	新生入学教育			0.5		0.5	0.5		0.5		0.5							
2		军训			2		2	2		2		2							
3		劳动			1		1	1		1			0.5	0.5					
4		社会实践			2		2	2		2			1		1				
5		专业实习及毕业实习			40		40	40		40								40	
实践环节合计		开设总周数			45.5		45.5	45.5		45.5		2.5	1.5	0.5	1			40	
		周实践周数										0.17	0.08	0.03	0.06				
1	专业限定选修课	专项提高课		5	1		1	18		18						18			
2		功能解剖学	5		2	1.5	0.5	36	24	12						36			
3		运动康复器械组合训练		6	1	0.5	0.5	18	2	16							18		
4		体育科学研究方法		6	1	1		20	20								20		
合计					5	3	2	92	46	46						54	38		
公共选修课		人文类课程不少于 9 学分			16														
1	创新学分	创新实践学分			≥1														
2		公益活动学分			≥1														
3		讲座学分			≥1														
合计					6														
思想品德学分					6														
总学分					210														