·综 述·

# 儿童青少年体力活动与身心健康研究进展

马渊源[1],陈勤[2],尹小俭[3,4],吴慧攀[1],康栩烨[5],侯宇欣[5],靳雪钰[6]

1.太原工业学院儿童青少年健康促进研究中心,山西 030008;2.湖南人文科技学院体育学院;
3.上海应用技术大学经济与管理学院;4.华东师范大学体育与健康学院;5.山西大学体育学院;6.太原工业学院体育系

【摘要】 近几十年,儿童青少年体力活动水平下降趋势明显,导致其健康水平下降,新冠肺炎疫情的暴发与蔓延进一步加重了该趋势。在疫情防控常态化背景下,为深入解析体力活动与儿童青少年身心健康之间的关系,促进儿童青少年身心健康水平,追踪梳理了国内外相关主题文献,分析了体力活动对儿童青少年健康体适能、认知和心理健康的积极影响,发现相关健康效应存在显著的体力活动类型、强度和时间差异等,进而提出了体力活动相关研究的若干问题。

【关键词】 运动活动;身体素质;精神卫生;儿童;青少年

【中图分类号】 G 806 R 179 【文献标识码】 A 【文章编号】 1000-9817(2022)04-0632-06

**Research update on association of physical activity with physical and mental health among children and adolescents**/*MA Yuanyuan**, *CHEN Qin, YIN Xiaojian, WU Huipan, KANG Xuye, HOU Yuxin, JIN Xueyu.* * *Research Center for Health Promotion of Children and Adolescents, Taiyuan Institute of Technology, Taiyuan* (030008), *China.*

【**Abstract**】 In recent decades, there is a decreasing trend in physical activity, which might be associated with decline in physical and mental health among children and adolescents in China. The outbreak and spread of the COVID-19 further aggravated this trend. Under the background of normalized epidemic prevention and control, in order to deeply understand the relationship between physical activity and physical and mental health of children and adolescents, this study sorted out relevant domestic and foreign literatures, and analyzed the effects of physical activity on children and adolescents' health and fitness. The positive effects of physical activity, cognition, and mental health were found to be significantly different in the type, intensity, and time of physical activity in the related health effects.

【**Keywords**】 Motor activity; Physical fitness; Mental health; Child; Adolescent

近几十年,伴随着社会快速发展以及生活方式的巨大改变,儿童青少年体力活动水平已在世界范围内呈现出明显的下降趋势。世界卫生组织(WHO)2018年发布报道称,在全球范围内约有81%的在校儿童青少年存在体力活动不足,改善其体力活动水平已迫在眉睫[1]。随着新型冠状病毒肺炎(COVID-19)疫情的暴发与蔓延,儿童青少年长期处于防疫常态中将加剧这一下降趋势。诸多研究表明,目前儿童青少年体力活动水平相比疫情前下降明显,超重肥胖[2]、心肺耐力[3]等问题愈加严峻,罹患焦虑、沮丧等心理疾病的儿童青少年比例大幅上升[4],严重影响儿童青少年的健康成长。客观、全面地阐述体力活动与儿童青少年身心健康之间的关系,探讨影响两者关系的各类因素,将有利于在疫情防控常态化背景下对儿童青少年体力活动水平提出更为科学的建议,并系统规划儿童青少年体力活动水平的合理区间,从而达到提高我国儿童青少年健康水平的目的,为实现"健康中国"的目标提供参考借鉴。

## 1 体力活动概念界定

20世纪80年代,Caspersen等[5]指出,体力活动(physical activity,PA)是由骨骼肌收缩导致能量代谢高于基础水平的身体活动和任何身体活动,与运动(exercise)是不同的概念。90年代,美国卫生部对体力活动进行了更为精确的定义:体力活动是通过骨骼肌收缩产生能量消耗并提高健康受益的身体运动[6],这个概念中提及到了一个关键理念,即"健康受益"。就目前进行的体力活动研究而言,大多采用或者依据本概念作为其概念界定的基础,然后依据"属加种差"对操作定义进行界定。在此定义基础上,多数学者和机构赞同体力活动强度应该划分为久坐、轻度、中度和剧烈等类型[7]。本文即是在上述概念界定与分类基础上进行体力活动与身心健康之间的探讨。

【基金项目】 上海市哲学社会科学2020年度规划课题项目(2020BTY001);山西省哲学社会科学2021年度规划课题项目(2021YJ121)

【作者简介】 马渊源(1992- ),男,山西长治人,硕士,助教,主要研究方向为青少年健康促进干预。

【通信作者】 陈勤,E-mail:35223021@qq.com

DOI: 10.16835/j.cnki.1000-9817.2022.04.036

## 2　体力活动与儿童青少年健康体适能

健康体适能是指个体执行日常生活和工作中体力活动的能力,与人体的健康密切相关,由身体成分、身体呼吸循环系统、肌肉骨骼系统(肌肉耐力,力量,柔软,平衡)组成[8]。

2.1　*体力活动与体质量指数(BMI)*　BMI 因其计算的简便性以及科学性,被国际上作为衡量人体营养状况的常用指标。诸多学者基于不同角度和不同的研究设计,探讨体力活动对儿童青少年 BMI 的影响。Larsen 等[9]在研究中发现,与不参加体力活动的儿童相比,参加 PA 较多(尤其是参与球类运动)的儿童 BMI 更趋近于正常范围。此外,体力活动与肥胖的相关性随着体力活动强度的增加而增强,且在不同性别中均表现出交互作用[10]。但并非所有的研究结果都支持体力活动与儿童青少年营养状况之间具有上述关系,如 Tambalis 等[11]研究表明,由于儿童青少年处于生长发育的关键时期,并没有足够的证据表明体力活动水平一定是影响儿童青少年 BMI 的主要因素。此外,一些针对特定运动项目的研究对体力活动与儿童青少年营养状况的相关性同样持质疑态度。Krstevski 等[12]研究表明,每周练习≥3 次的青少年篮球运动员相较于一般运动员具有更高的身高、更长的臂展、更低的体脂率和更高的肌肉占比以及更符合健康标准的 BMI。而能否表明体力活动一定是造成该结果的主要原因,仍需要进行更为深入的探讨。

2.2　*体力活动与心肺耐力*　心肺耐力综合反应人体摄取、转运和利用氧的能力,牵涉到心脏泵血功能、肺部摄氧及交换气体能力、血液循环系统携带氧气至全身各部位的效率,以及肌肉等组织利用这些氧气的效率,是体质健康中的核心要素[13]。研究表明,中高强度的体力活动(MVPA)可使儿童青少年心肺器官产生适应性变化,同时随着体力活动量的增加,心血管疾病危险的累积效应也会减弱,对促进儿童青少年的身心健康具有重要意义[14]。张海平等[15]在对中学生最大摄氧量($VO_{2max}$)的研究发现,进行心肺耐力运动干预后,实验组 $VO_{2max}$ 的绝对值和相对值均得到了显著提高。Meng 等[16]研究发现,与中等强度持续训练相比,高强度间歇性训练在改善 6~17 岁健康儿童和青少年心肺功能方面更为有效。Pojskic 等[17]对在校学生群体的研究中也得出相似结论,即心肺耐力水平与体力活动不同强度间表现显著相关。但也有部分研究呈现出不同的结果,Rena 等[18]在体育活动对小学生心肺适能影响的研究中发现,在多变量模型、预编程体重状况下实验组和对照组学生的心肺耐力水平虽然都有进步,但两组之间的进步差异不大,最终结论倾向于无论儿童的初始体重类别如何,BMI 总体情况、心肺功能变化与是否参与体力活动均无显著相关。Pojskic 等[17]对波斯尼亚和黑塞哥维那等地区儿童的研究中发现,符合标准 PA 时长的儿童占比相对较高,但超过 80%儿童的心肺耐力水平仍较低,PA 总时长与学龄儿童心肺耐力间并不具有独立相关关系,并提出应更加深入探讨体力活动与心肺耐力间的生理学机制。综上所述,当前研究普遍支持体力活动可以作为改善儿童青少年心肺功能的有效手段之一,但体力活动的方式和强度类型对于改善心肺耐力水平的效果则呈现不同的结果。

2.3　*体力活动与力量*　力量素质是指肌肉工作时克服阻力或对抗负荷的能力,是肌肉进行各种工作的基础,是身体完成各种动作的动力来源,也是判断儿童青少年身体发育状况的重要指标之一[19]。Leppanen 等[20]研究表明,在儿童 4.5~5.5 岁成长发育阶段中,参与中等强度以上的体力活动量与未来上、下肢肌肉力量及下肢暴发力的发展呈正相关。该研究还发现,自幼儿阶段起,持续保持或提升 MVPA 可延续力量素质对健康的积极影响。Myers 等[21]研究发现,青少年在经过抗阻训练后产生了一系列生理和代谢层面的适应性变化,肌肉力量和质量表现出总体增加趋势。还有学者选用具体运动项目作为体力活动对儿童青少年力量素质影响的干预手段,如 Mcleodi[22]选用大肌肉群参与度较高的游泳作为干预手段,发现由于水中任务直接刺激相关大肌群,使儿童青少年相应的大肌肉力量素质得到显著提高。张腾等[23]在游泳对幼儿力量素质发展影响的研究中发现,幼儿参与游泳可在一定范围内对大肌肉动作发展产生促进作用,且对幼儿的移动性、技能稳定性及大肌肉动作方面均有一定的积极影响。

2.4　*体力活动与柔韧性*　柔韧性是指人体在运动过程中完成大幅度运动技能的能力,对于快速、有力、轻松、富有表现力的高难度运动技能的学习和掌握有重要影响[24]。该类研究大多以具体的运动项目为干预手段分析体力活动与柔韧性之间的联系。Suarez 等[25]在乒乓球专项运动员的训练内容中加入有氧运动干预(越野训练和基础健美操),结果发现,有氧运动干预对运动员柔韧性及灵活性的发展具有积极影响。张丽[26]在跆拳道教学研究中发现,柔韧素质练习可提高专项技术动作的协调性与优美性,提升高难度技术动作的完成质量,还能够辅助学生力量素质和动作速度的提升。王小娟[27]在关于平衡素质影响因素的研究中发现,一般体能训练对学生平衡素质的发展具有积极影响。

## 3　体力活动对儿童青少年认知与心理健康的影响

心理健康是一种健康或幸福状态,在这种状态

下,个体可以实现自我、能够应对正常的生活压力、工作富有成效和成果以及有能力对所在社会做出贡献[28]。通过梳理各类体力活动与儿童青少年心理健康及认知间关系的研究发现,当前研究主要聚焦于体力活动对儿童青少年的认知改善、自尊提升、抑郁和焦虑减缓等方面[29-30]。

3.1 *体力活动对认知能力的影响* 认知能力是指人脑加工、储存和提取信息的能力,是个体认识客观世界,获得各种知识的主要能力之一,对于儿童青少年反应速度的提升、警觉性和注意力改善等方面具有重要作用[31]。研究表明,有规律的体力活动可以刺激神经,对于改善个体认知能力存在显著的积极影响[32]。在此基础上,部分研究对体力活动影响认知能力的生理机制进行了进一步的探讨,如 Jackson 等[33]研究认为,体力活动在动作的启动、过程控制、适应、调节、监测等方面对高级认知功能有积极影响。Lioyd 等[34]研究表明,无论自愿还是强制的体力活动均会使控制认知和情绪行为的大脑区域 mTOR 信号增强,而 mTOR 已被证实与认知、记忆和抑郁水平直接相关,同时青少年认知能力和学习成绩与体力活动存在显著相关[35],体力活动对青少年注意力的集中与保持、记忆、反应速度以及认知控制等方面具有积极影响,但对信息任务的处理速度影响较小[36]。

3.2 *体力活动对自尊的影响* 自尊是儿童青少年人格特质的一个重要组成部分,其水平在很大程度上将会影响儿童青少年的社会行为和心理健康发展。研究表明,自尊较高的个体被认为具有更好的选择和判断能力,能够更好地避免压力性事件的有害后果[37]。一项荟萃分析显示,无论观察性研究还是实验性研究,体力活动与自尊的改善均呈现正相关,并且是增强自尊的重要因素,如从事体育活动较为频繁的学生相比从事体育活动较少的群体,有着更高的自尊水平[38]。但是鉴于自尊具有多维度和层次化的特点,并非所有研究结果都支持体力活动与自尊水平之间呈直接的相关关系,而是需要某些中介因素为前提条件。如 Fernandez-Bustos 等[39]研究认为,身体意象是体力活动与自尊间最重要的中介因素之一,身体意象直接决定了个体尤其是儿童青少年个体自尊的建立[40]。也有研究认为,BMI 和身体不满意度也属于体力活动与自尊间的重要中介因素[41-42]。另外,体力活动与个体自尊间的相关程度,在性别和运动项目间有显著差异[43-44]。

3.3 *体力活动对焦虑的影响* 焦虑是最常见的心理健康障碍之一,严重影响个体注意力、睡眠和执行日常任务的能力。伴随着学业、升学等压力的不断增大,焦虑已经成为儿童青少年群体中最为普遍的心理问题与疾病之一。新冠肺炎疫情的暴发,更是进一步加剧该趋势的发展。在 COVID-19 疫情暴发期间,我国青少年焦虑性情绪障碍患病率较非疫情期间上升 4.1%[45],儿童青少年的心理障碍和创伤后应激障碍程度同样高于疫情前水平[46-48]。对于儿童青少年群体来讲,体力活动对于预防和控制焦虑症状具有不可替代的作用。Chen 等[49]研究指出,保持规律的体力活动有助于青少年从 COVID-19 疫情隔离期间出现的心理健康问题中恢复,特别对焦虑作用更为显著。部分研究从生理学的视角进行了阐释,适当的体力活动可对身体内啡肽水平[30]、体温[50]、线粒体功能[36,51]、神经递质分泌量[52]等方面造成影响,进而改善情绪状态和焦虑水平[53]。必须强调的是,在以上提及的研究中,并未讨论有氧运动和非有氧运动的影响差异。提示体力活动可以有效改善焦虑症状,并且可能是治疗焦虑的一种可行的辅助治疗方法,且在业内已经得到普遍认可。

3.4 *体力活动对抑郁的影响* 抑郁是一种自我无助和自我无力状态的情感表达,易使儿童青少年产生消极化的思维、情绪和行为,导致生活满意度、主观幸福感等指标下降,甚至导致极端行为的产生,如自杀、自虐等。研究表明,体力活动是缓解青少年抑郁症患者症状较为有效的措施[54]。一项涉及 4 257 名调查者的研究表明,在青春期早期的久坐时间与其在 18 岁时的抑郁水平呈正相关,而体力活动量与抑郁水平呈负相关[55]。此外,Bailey 等[56]研究结果显示,低等、中等和大强度体力活动干预均与抑郁症状的减轻存在显著相关。Mehrpooya 等[57]在对体力活动与抑郁症身心交互机制的研究中发现,辅酶 Q10 合成紊乱对线粒体功能的影响是抑郁症的致因之一,而体力活动对辅酶 Q10 合成通路有显著积极影响,解释了体力活动改善抑郁症状的生理学机制,但缺乏针对儿童青少年样本的研究支持[58]。

当前研究虽普遍认为体力活动对个体认知和心理健康具有一定程度的积极影响,但有关身体活动在认知和心理健康发展过程中的作用仍然知之甚少。已有证据表明,心理健康问题可能导致身体活动减少和久坐行为增加,因此当前的横断面研究多基于假设心理健康和身体活动间存在双向关联[59]。而青少年体力活动与以后的抑郁和焦虑症状之间是否具有前瞻性的关联仍缺乏研究佐证。直接证据的缺乏可能与体力活动和心理健康结果的测量方式限制有关,也可能受干预手段对健康人群的预期影响较小所致。总之,当前研究普遍倾向于认为儿童青少年体力活动水平与其长期心理健康发展密切相关,但证据基础普遍薄弱且存在一定的局限性,如研究对象样本量不足、缺乏全球代表性,也存在样本自述的过度使用以及测量方式不完善等情况,因此需要更多高质量的研

究来深入探讨青少年体力活动对认知和心理健康的影响[60]。

## 4　总结与展望

综上所述,大部分研究支持体力活动可促进儿童青少年身心健康发展。这种正相关关系在部分具有特定要求的体力活动中非常显著,如规律且组织性强的体力活动或高强度间歇性的体力活动往往与儿童青少年的健康发展呈现出显著相关,但仍有若干问题不可忽视:(1)体力活动总量和/或体力活动总时长与儿童青少年身心健康间的关系仍存在争议,原因可能在于当前各项研究采用的干预手段、测量标准以及样本人群均存在较大差异,也导致不同研究结果间很难进行横向对比分析。同时当前研究缺乏对体力活动与儿童青少年身心健康间量效关系的探索。(2)关于体力活动对儿童青少年心理健康状况影响主要以短期干预和横断面研究为主,缺乏深入探讨两者间因果关系的纵向研究。此类研究缺乏对生活幸福感、自我效能感、焦虑、身体不满意度等其他心理健康构成要素与体力活动间量效关系的探讨。(3)具体到体力活动的干预,缺乏对体力劳动、非自愿或强迫性体力活动等其他体力活动方式与儿童青少年健康促进间关系的研究,缺乏对以家庭、社会群体等其他群体为单位开展体力活动的研究,缺乏特殊儿童青少年群体,如抑郁、焦虑症患者及留守儿童等特殊群体的研究。

在未来开展的相关研究中,必须考虑以上存在的诸多问题,进一步从体力活动强度、频率、方式等方面探讨体力活动与身心健康之间的关系;从纵向研究的角度思考体力活动与儿童青少年身心健康的关系;从干预对象多元化,干预方法多样化和干预内容丰富化 3 个方面拓展体力活动对儿童青少年健康促进影响方面的研究,为更好地促进儿童青少年身心健康发展提供理论和实践支持。

**利益冲突声明**　所有作者声明无利益冲突。

## 5　参考文献

[1] WHO. Physical activity in the Western Pacific[R]. Switzerland: WHO, 2018.

[2] CASTAEDA-BABARRO A, ARBILLAGA-ETXARRI A, GUTIERREZ-SANTAMARIA B, et al. Physical activity change during COVID-19 confinement[J]. Int J Env Res Pub Health, 2020, 17(18): 90-98.

[3] JEFFREY A, WOOD S. The COVID-19 pandemic and physical activity[J]. Sports Med Health Sci, 2020, 2(2): 55-64.

[4] OKUYAMA J. Mental health and physical activity among children and adolescents during the COVID-19 pandemic[J]. Tohoku J Exp Med, 2021, 253(3): 203-215.

[5] CASPERSEN C J, POWELL K E, CHRISTENSON G M. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research[J]. Public Health Rep, 1985, 100(2): 126-131.

[6] PATE R R, PRATT M, BLAIR S N, et al. Physical activity and public health. A recommendation from the centers for disease control and prevention and the american college of sports medicine[J]. JAMA, 1995, 273(5): 402-407.

[7] ROSTRON Z P. Associations between measures of physical activity and muscle size and strength: a systematic review[J]. Arch Rehab Res Clin Transl, 2021, 3(2): 100124.

[8] 杨洪杰,王艳,刘善云.男大学生功能动作表现与健康体适能的关系[J].中国学校卫生,2020,41(12):1863-1867.
YANG H J, WANG Y, LIU S Y. Relationship between functional movement performance and health-related physical fitness of male college students[J]. Chin J Sch Health, 2020, 41(12): 1863-1867.

[9] LARSEN M N, NIELSEN C M, ORNTOFT C, et al. Physical fitness and body composition in 8-10-year-old Danish children are associated with sports club participation[J]. J Strength Cond Res, 2017, 31(12): 3425-3434.

[10] MARQUES A, MINDERICO C, MARTIND D, et al. Cross-sectional and prospective associations between moderate to vigorous physical activity and sedentary time with adiposity in children[J]. Int J Obes (Lond), 2016, 40: 28-33.

[11] TAMBALIS K D, PANAGIOTAKOS D B, PSARRA G, et al. Concomitant associations between lifestyle characteristics and physical activity status in children and adolescents[J]. J Res Health Sci, 2019, 19(1): 23-34.

[12] KRSTEVSKI B, POPOVSKI L, TODOROVSKI S, et al. Differences in some anthropometric characteristics, body composition and motor capabilities in 12-year old basketball players that train two, three and more times per week res[J]. Phys Educ Sport Health, 2019, 8: 31-34.

[13] 尹小俭.心肺耐力是儿童青少年体质健康的重要维度[J].中国学校卫生,2017,38(12):1761-1764.
YIN X J. Cardiopulmonary endurance is an important dimension of children and adolescents' physical health[J]. Chin J Sch Health, 2017, 38(12): 1761-1764.

[14] DRENOWATZ C, PRASAD V K, WHAND G A, et al. Effects of moderate and vigorous physical activity on fitness and body composition[J]. Behav Med, 2016, 39: 624-632.

[15] 张海平,刘兴,吴翊馨,等.12~14 岁中学生日常体力活动状况及健身跑对其心肺耐力影响的研究[J].沈阳体育学院学报,2016,35(1):93-96.
ZHANG H P, LIU X, WU Y X, et al. Status of daily physical activity and impact of fitness running on the cardiopulmonary endurance in middle school students of 12 to 14 years[J]. J Shenyang Sport Univ, 2016, 35(1): 93-96.

[16] MENG C, MINGHUI Q J. Effect of high-intensity interval training versus moderate intensity continuous training on cardiorespiratory fitness in children and adolescents: a Meta-analysis[J]. Int J Environ Res Public Health, 2019, 16(9): 67-73.

[17] POJSKIC H, ESLAMI B. Relationship between obesity, physical activity and cardiore-spiratory fitness levels in children and adolescents in bosnia and herzegovina: an analysis of gender differences[J]. Front Physiol, 2018, 9: 1734.

[18] RENA C, MOON M D, MPH S A. Cunningham PHD and julie gazmararian phd mph Impact of weight status on the cardiopulmonary fitness outcome of a school based physical activity program[J]. J Sch

Health, 2020, 90(10): 762-770.

[19] 马园艳.体育舞蹈专项力量素质训练内容体系构建研究[D].西安:西安体育学院,2013.
MA Y Y. Construction of dancesport strength training content system [D]. Xi'an: Xi'an Physical Education University, 2013.

[20] LEPPANEN M H, HENRIKSSON P, DELISLE N C, et al. Longitudinal physical activity, body composition, and physical fitness in preschoolers[J]. Med Sci Sports Exerc, 2017, 49(10): 2078-2085.

[21] MYERS A M, BEAM N W, FAKHOURY J D. Resistance training for children and adolescents[J]. Pediatrics, 2017, 6(3): 37-143.

[22] MCLEOD I. Swimming anatomy[M]. Cleveland: Hum Kin Pub, 2019: 76-89.

[23] 张腾,温宇红,赵响,等.游泳影响幼儿大肌肉动作发展:横向与干预研究的证据[J].杭州师范大学学报(自然科学版),2021,20(2):208-216.
ZHANG T, WEN Y H, ZHAO X, et al. Effect of swimming on preschool children's gross motor development: evidence from cross-sectional and intervention study[J]. J Hangzhou Nor Univ (Nat Sci Edit), 2021, 20(2): 208-216.

[24] 邓树勋,王健,乔德才,等.运动生理学[M].北京:高等教育出版社,2015:223-244.
DENG S X, WANG J, QIAO D C, et al. Athletic physiology[M]. Beijing: Higher Education Press, 2015: 223-244.

[25] SUAREZ M S, MARTINEZ-LOPE Z E J, DELA T M, et al. Analysis of effect size of overweight in flexibility among adolescents: reference values for physical education according to gender, age and BMI[J]. S Afr J Res Sport Phisc, 2019, 41(2): 73-85.

[26] 张丽.跆拳道教学中的柔韧素质训练研究[J].当代体育科技,2018,8(31):31-33.
ZHANG L. Research on flexibility training in taekwondo teaching[J]. Cont Sport Sci Tech, 2018, 8(31): 31-33.

[27] 王小娟.一般体能训练对小学生身体素质影响的实验研究[D].北京:首都体育学院,2016.
WANG X J. Experimental study on the effect of general physical fitness training on physical fitness of elementary school students[D]. Beijing: Capital University of Physical Education and Sports, 2016.

[28] 俞国良,董妍.我国心理健康研究的现状,热点与发展趋势[J].教育研究,2012,33(6):97-102.
YU G L, DONG Y. The status quo, hotspot, and development tendency of mental health in China[J]. Educ Rese, 2012, 33(6): 97-102.

[29] RAGLIN J S. Exercise and mental health: beneficial and detrimental effects[J]. Sports Med, 1990, 9(6): 323.

[30] CHEN C, NAKAGAWA S, AN Y, et al. The exercise-glucocorticoid paradox: how exercise is beneficial to cognition, mood, and the brain while increasing glucocorticoid levels[J]. Front Neuroendocrin, 2017, 44: 83-102.

[31] KILLGORE W D S. Effects of sleep deprivation on cognition[J]. Prog Brain Res, 2010, 185: 105-129.

[32] TIVADAR B K. Physical activity improves cognition: possible explanations[J]. Biogerontology, 2017, 18(4): 477-483.

[33] JACKSON W M, DAVIS N, SANDA S A, et al. Physical activity and cognitive development: a Meta-analysis[J]. J Neurosurg Anesthesiol, 2016, 28(4): 373-380.

[34] LIOYD B A, HAKE H S, ISHIWATA T, et al. Exercise increases mTOR signaling in brain regions involved in cognition and emotional behavior[J]. Behav Brain Res, 2017, 323: 56-67.

[35] SINGH A S, SALIASI E, VANDENBERG V, et al. Effects of physical activity interventions on cognitive and academic performance in children and adolescents: a novel combination of a systematic review and recommendations from an expert panel[J]. Br J Sports Med, 2019, 53(10): 640-647.

[36] PONTIFEX M B, MCGOWAN A L, CHANDLER M C, et al. A primer on investigating the after effects of acute bouts of physical activity on cognition[J]. Psychol Sport Exerc, 2019, 40: 1-22.

[37] MOKSNES U K, MOLJORD I E O, ESONES G A, et al. The association between stress and emotional states in adolescents: the role of gender and self-esteem[J]. Pers Indiv Diff, 2010, 49(5): 430-435.

[38] KAYANI S, KIYANI T, WANG J, et al. Physical activity and academic performance: the mediating effect of self-esteem and depression [J]. Sustainability, 2018, 10(10): 3633.

[39] FERNANDEZ-BUSTOS J G, INFANTES-PANIAGUA A, CUEVAS R, et al. Effect of physical activity on self-concept: theoretical model on the mediation of body image and physical self-concept in adolescents[J]. Health Soc Care Comm, 2019, 10: 1537.

[40] FENTON C, BROOKS F, SPENCER N H, et al. Sustaining a positive body image in adolescence: an assets-based analysis[J]. Health Soc Care Comm, 2010, 18(2): 189-198.

[41] ANEZ E, FORNIELES-DEU A, FAUQUET-ARS J, et al. Body image dissatisfaction physical activity and screen-time in Spanish adolescents [J]. J Health Psychol, 2018, 23(1): 36-47.

[42] REDDON H, MEYRE D, CAIRNEY J. Physical activity and global self-worth in a longitudinal study of children[J]. Med Sci Sport Exerc, 2017, 49(8): 1606-1613.

[43] FERNANDEZ J G, CONTRERAS O R, GARCIA L M, et al. Autoconcepto fisico segunla actividad físicodeportiva realizaday lamotivacion hacia esta[J]. Rev Lat Psi, 2010, 42(2): 251-263.

[44] FERNANDEZ-BUSTOS J G, GONZALEZ-MARTI, JORDAN O R C, et al. Understanding the relationship between physical activity and physical self-perception in adolescent females: the role of body image [J]. Int J Sport Psychol, 2016, 47(4): 373-388.

[45] 赵禄雷.疫情对小学高年级学生情绪的影响及调适策略研究[J].辽宁教育,2020(20):64-67.
ZHAO L L. Study on the influence of epidemic situation on emotion of senior primary school students and adjustment strategies[J]. Liaoning Educ, 2020(20): 64-67.

[46] LIANG L, REN H, CAO R, et al. The effect of COVID-19 on youth mental health[J]. Psychiat Q, 2020, 91(3): 841-852.

[47] ZHENG W. Mental health and a novel coronavirus (2019-NCOV) in China[J]. J Affect Disord, 2020, 269: 201-202.

[48] TANG W, HU T, HU B, et al. Prevalence and correlates of ptsd and depressive symptoms one month after the outbreak of the COVID-19 epidemic in a sample of home-quarantined Chinese university students [J]. J Affect Disord, 2020, 274: 1-7.

[49] CHEN P, MAO L, NASSIS G P, et al. Returning Chinese school-aged children and adolescents to physical activity in the wake of COVID-19: actions and precautions[J]. J Sport Health Sci, 2020, 9(4): 322-324.

[50] PETRUZZELLO S J, LANDERS D M, SALAZAR W. Exercise and anxiety reduction: examination of temperature as an explanation for affective change[J]. J Sport Exerc Psyic, 1993, 15(1): 63-76.

(下转第 640 页)

[24] D'ESPOSITO M, POSTLE B R. The cognitive neuroscience of working memory[J]. Ann Rev Psychol, 2015, 66: 115-142.
[25] MARTÍN-PERPIÑÁ M M, VIÑAS POCH F, MALO CERRATO S. Media multitasking impact in homework, executive function and academic performance in Spanish adolescents[J]. Psicothema, 2019, 31(1): 81-87.
[26] RALPH B C, SMILEK D. Individual differences in media multitasking and performance on the n-back[J]. Atten Percept Psychophys, 2017, 79(2): 582-592.
[27] UNCAPHER M R, KTHIEU M, WAGNER A D. Media multitasking and memory: differences in working memory and long-term memory[J]. Psychon Bull Rev, 2016, 23(2): 483-490.
[28] SPENCE A, BEASLEY K, GRAVENKEMPER H, et al. Social media use while listening to new material negatively affects short-term memory in college students[J]. Physiol Behav, 2020, 227: 113172.
[29] MADORE K P, KHAZENZON A M, BACKES C W, et al. Memory failure predicted by attention lapsing and media multitasking[J]. Nature, 2020, 587(7832): 87-91.
[30] CARDOSO-LEITE P, KLUDT R, VIGNOLA G, et al. Technology consumption and cognitive control: contrasting action video game experience with media multitasking[J]. Atten Percept Psychophys, 2016, 78(1): 218-241.
[31] KORTE M. The impact of the digital revolution on human brain and behavior: where do we stand? [J]. Dialogues Clin Neurosci, 2020, 22(2): 101-111.
[32] EDWARDS K S, SHIN M. Media multitasking and implicit learning[J]. Atten Percept Psychophys, 2017, 79(5): 1535-1549.
[33] MINEAR M, BRASHER F, MCCURDY M, et al. Working memory, fluid intelligence, and impulsiveness in heavy media multitaskers[J]. Psychon Bull Rev, 2013, 20(6): 1274-1281.
[34] PARRY D A, ROUX D. Media multitasking and cognitive control: a systematic review of interventions[J]. Comput Human Behav, 2019, 92: 316-327.
[35] BAUMGARTNER S E, WEEDA W D, VAB DER HEIJDEN L L, et al. The relationship between media multitasking and executive function in early adolescents[J]. J Early Adolesc, 2014, 34(8): 1120-1144.
[36] LUO J T, YEUNG P, LI H. The relationship among media multitasking, academic performance and self-esteem in Chinese adolescents: the cross-lagged panel and mediation analyses[J]. Child Youth Serv Rev, 2020, 117: 105308.
[37] LUI K F, WONG A C. Does media multitasking always hurt? A positive correlation between multitasking and multisensory integration[J]. Psychon Bull Rev, 2012, 19(4): 647-653.
[38] WIRADHANY W, VAN VUGT M K, NIEUWENSTEIN M R. Media multitasking, mind-wandering, and distractibility: a large-scale study[J]. Atten Percept Psychophys, 2020, 82(3): 1112-1124.
[39] WEN T, LIU D C, HSIEH S. Connectivity patterns in cognitive control networks predict naturalistic multitasking ability[J]. Neuropsychologia, 2018, 114: 195-202.
[40] DEPREZ S, VANDENBULCKE M, PEETERS R, et al. The functional neuroanatomy of multitasking: combining dual tasking with a short term memory task[J]. Neuropsychologia, 2013, 51(11): 2251-2260.
[41] KOBAYASHI K, OISHI N, YOSHIMURA S, et al. Relationship between media multitasking and functional connectivity in the dorsal attention network[J]. Sci Rep, 2020, 10: 17992.
[42] MOISALA M, SALMELA V, HIETAJÄRVI L, et al. Media multitasking is associated with distractibility and increased prefrontal activity in adolescents and young adults[J]. Neuroimage, 2016, 134: 113-121.
[43] HOROWITZ-KRAUS T, HUTTON J S. Brain connectivity in children is increased by the time they spend reading books and decreased by the length of exposure to screen-based media[J]. Acta Paediatr, 2018, 107(4): 685-693.
[44] HUTTON J S, DUDLEY J, HOROWITZ-KRAUS T, et al. Associations between screen-based media use and brain white matter integrity in preschool-aged children[J]. JAMA Pediatr, 2020, 174(1): e193869.
[45] WEINSTEIN A, LIVNY A, WEIZMAN A. New developments in brain research of Internet and gaming disorder[J]. Neurosci Biobehav Rev, 2017, 75: 314-330.

**收稿日期**: 2021-11-07 **本文编辑**: 汤建军

(上接第 636 页)

[51] WATSON K, BAAR K. mTOR and the health benefits of exercise[J]. Emin Cell Dev Biol, 2014, 36: 130-139.
[52] CLARK A, MACH N. Exercise-induced stress behavior, gut-microbiota-brain axis and diet: a systematic review for athletes[J]. J Int Soc Sport Nutr, 2016, 13(1): 1-21.
[53] DZIUBEK W, KOWALSKA J, KUSZTAL M, et al. The level of anxiety and depression in dialysis patients undertaking regular physical exercise traininga preliminary study[J]. Kidney Blood Press Res, 2016, 41(1): 86-98.
[54] ERSKINE H E, MOFFITT T E, COPELAND W E, et al. A heavy burden on young minds: the global burden of mental and substance use disorders in children and youth[J]. Psychol Med, 2015, 45(7): 1551-1563.
[55] KANDOLA A, LEWIS G, OSBORN D P J, et al. Depressive symptoms and objectively measured physical activity and sedentary behaviour throughout adolescence: a prospective cohort study[J]. Lancet Psychiatry, 2020, 7(3): 262-271.
[56] BAILEY A, HETRICK S, ROSENBAUM S, et al. Treating depression with physical activity in adolescents and young adults: a systematic review and Meta-analysis of randomised controlled trials[J]. Psychol Med, 2018, 48(7): 1068-1083.
[57] MEHRPOOYA M, YASREBIFAR F, HAGHIGHI M, et al. Evaluating the effect of coenzyme Q10 augmentation on treatment of bipolar depression: a double-blind controlled clinical trial[J]. J Clin Psychopharm, 2018, 38(5): 460-466.
[58] SAMPASA-KANYINGA H, GOLMAN I, COLDFIELD G S, et al. Combinations of physical activity, sedentary time, and sleep duration and their associations with depressive symptoms and other mental health problems in children and adolescents: a systematic review[J]. Int J Behav Nutr Phyic, 2020, 17: 1-16.
[59] LUBANS D, RICHARDS J, HILLMAN C, et al. Physical activity for cognitive and mental health in youth: a systematic review of mechanisms[J]. Pediatrics, 2016, 138(3): 178-190.
[60] VAN SLUIJS E M F, EKELUND U, CROCHEMORE-SILVA, et al. Physical activity behaviours in adolescence: current evidence and opportunities for intervention[J]. Lancet, 2021, 398(10298): 429-442.

**收稿日期**: 2021-10-07 **修回日期**: 2021-12-01 **本文编辑**: 王苗苗