

移动互联网应用程序在康复领域的应用

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摘要 依托于互联网技术的移动应用程序(APPs)已经成为日常生活中不可或缺的一部分,并逐渐应用于临床康复治疗中。APPs辅助康复拓展了康复场景,使康复评定更加简单、便捷,使训练形式更加智能多样,在康复评定、康复训练和提高社会活动参与能力方面有诸多应用。本研究就国内外APPs在康复领域的应用进行综述,以期发挥APPs和康复结合的最大效能,为进一步发展移动互联网康复治疗提供依据。APPs在康复评定中可用于辅助关节活动度评定、平衡功能及步态评定、言语及认知心理功能评定;在康复训练中可用于辅助上肢功能训练、慢性疼痛康复训练、平衡及步态训练、认知心理功能训练和其他功能训练等;APPs在提高患者社会活动参与中可用于辅助日常生活活动、提高工作及学习参与能力、辅助娱乐休闲活动等。将APPs应用于康复领域,可简化康复评定、治疗过程,拓展康复训练场景,使康复形式更加智能化、多元化,提高患者训练时的积极性和依从性,促进康复治疗的快速发展。但APPs在康复领域的应用还面临很多困难,如APPs应用普适性不强、功能相对单一、软件设计和使用不够规范等。下一步还需围绕互联网移动APPs与康复的有机结合展开研究,寻找并开发适合不同功能障碍者的综合APPs,以期发挥APPs辅助康复的最大功效。

关键词 移动互联网应用程序;康复治疗;康复评定;康复训练;智能康复

网络技术的发展改变了传统的生活方式,基于移动网络技术的互联网应用程序(applications, APPs)给人们的工作、学习、交流、娱乐及获取信息的方式带来了前所未有的革新与便利。越来越多的康复工作人员开始利用APPs开展临床康复治疗,为新时代康复医学的发展注入了新的动力。与传统康复比较,APPs辅助康复拓展了康复场景,使康复评定更加简单、便捷,使训练形式更加智能多样,能够有效改善功能障碍者的生理功能和心理功能,提高患者生活自理能力及社会参与度,呈现出巨大的优势及创新性。但是,APPs与康复的结合也面临诸多挑战,如APPs如何与康复结合以发挥各自的最大效能;APPs辅助康复在提升便利性的同时能否保证其

有效性等。目前,APPs在康复中的应用前景尚未明确。为此,本研究对APPs在康复中的应用进行综述,旨在为进一步发展移动互联网康复治疗提供依据。

1 APPs在康复中的应用

随着科技的发展,APPs在人们生活中的使用场景日益丰富,使用功能更加成熟完备,其可以帮助人们实现沟通交流、娱乐休闲、金融支付、获取信息以及购物等一系列功能。在新型冠状病毒感染疫情全球范围流行的背景下,健康码、行程码更成为人们在社会上的“通行证”,APPs也成为人们日常生活的必备工具^[1]。康复旨在促使功能障碍者最大限度地恢复躯体功能、心理功能及社会适应能力,使

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功能障碍者早日回归社会。APPs在康复中也逐渐得到推广应用。如视听类APPs可用于改善功能障碍者认知、言语障碍;沟通交流类APPs可用于提高功能障碍者社会参与能力;金融交易类APPs可用于

提高功能障碍者工作学习能力;休闲娱乐类APPs可用于满足功能障碍者娱乐需求等。目前APPs在康复领域中的应用主要集中于辅助康复评定、康复训练和提高社会活动参与能力等方面。见图1。

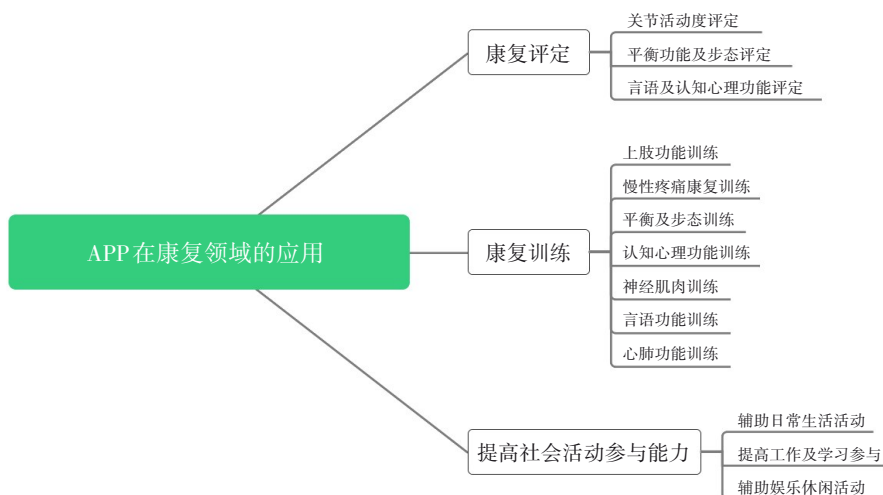


图1 APPs在康复领域的应用

Figure 1 Applications of APPs in rehabilitation service

1.1 APPs在康复评定中的应用

1.1.1 关节活动度评定 传统的关节活动度评定需要在治疗师的指导下借助量角器进行,费时费力且精确度欠佳。APPs通过与电子设备的内置传感器结合,可提高关节活动度评定的便利性和精确性,并能动态记录,及时反馈^[2-3]。有研究发现,使用APPs测量关节活动度的结果与常规量角器测量结果相关系数为0.94,提示APPs能够对关节活动度进行精准评定,具有良好的应用前景^[4]。APPs还能对膝关节关节炎患者的关节位置感、胸椎畸形患者的胸椎后凸角度、非特异性颈部疼痛患者的颅颈活动度等进行量化;也可以测量脑性瘫痪患者股骨前倾角度并对结果进行3D图像重建,这是常规量角器无法做到的。APPs评定结果更加多元化,可以使临床医生直观了解患者躯体功能情况^[5-8]。

1.1.2 平衡功能及步态评定 临床实践中常使用标准化评定量表(如Berg平衡量表、六分钟步行试验等)评定患者平衡功能及步态,但这些量表取决于治疗师对其运动表现的观察及分析能力,评定结果主观性较强,评定内容有限。标准的平衡及步态评估还可使用运动分析系统、3D运动捕捉系统,但其设备成本及对操作人员的要求较高,导致临床常难以推广使用^[9]。惯性传感器技术的进步使加速度计和陀螺仪可直接嵌入手机、平板等移动电子设备,

通过APPs数据量化姿势摇摆及时空步态参数,评定患者步态及平衡功能,成本低且便携易于使用^[10]。研究表明,APPs测量值与传统方式评定的Berg量表得分、共济失调量表得分等具有显著相关性($P < 0.0001$),表明APPs能够客观、精准地评定患者平衡功能和转移能力,量化步态变异性^[10-12]。但目前手机惯性传感器较其他评估系统的躯干传感器而言,敏感性较差,监测步态及平衡功能细微变化的能力较低,未来仍需对其进一步优化,以期提高APPs评估步态及平衡功能的有效性和可靠性。

1.1.3 言语及认知心理功能的评定 与传统的言语及认知心理功能评定量表比较,通过APPs评定言语及认知心理功能可以及时储存患者的评定数据(如失语症评估时的录音;认知评估时绘制的图形等),方便评定人员重复查看,得到最准确的评定结果^[13]。有研究表明,APPs可以通过语音指导患者对电子设备屏幕显示的几何图形进行轨迹跟踪,视觉提示诱导患者翻转卡片,以此评估患者的注意力、记忆力及执行力等神经认知功能^[14]。有随机对照研究结果显示,通过APPs评定得到的神经生理学测试分数与通过纸笔测试得到的分数具有显著相关性($r=0.92, P < 0.001$)^[15]。通过APPs发送问卷的形式通知或询问患者的位置、情绪以及是否服药等,可以评定患者精神心理和抑郁、焦虑症状,结果同

样具有较强的有效性,表明通过 APPs 评估患者言语及认知心理功能的可行性^[16]。但电子设备 APPs 使用时还需考虑如何消除背景噪声等问题,在临床应用中仍具一定挑战性。

1.2 APPs 在康复训练中的应用

1.2.1 上肢功能训练 传统上肢功能训练形式单一,内容乏味,患者缺少兴趣,参与治疗积极性不高。而 APPs 康复训练在传统训练基础上实现了康复训练形式的多元化,增加了训练趣味性。如桡骨远端骨折及手部骨关节炎患者可以利用“水果武士”“迷宫”“捕鱼”等游戏 APPs 进行拇指掌侧外展训练,通过“倾斜迷宫”进行手腕本体感觉训练等,这些 APPs 大大提高患者训练时的参与度和积极性^[17]。此外,APPs 辅助康复拓展了康复场景,使患者不再局限于在医院或康复机构进行康复训练,也可以在家里或社区完成康复训练。如脑卒中患者通过 VR 游戏可以在家进行上肢整体功能训练^[18];肩周炎患者通过手机视频可随时随地进行辅助被动前屈和交叉身体内收伸展训练^[19]。研究表明,与传统康复训练比较,使用 APPs 进行训练可更大范围地改善脑卒中患者上肢 Fugl-Meyer 评分和改良 Barthel 指数得分,降低肩周炎患者的疼痛视觉模拟评分^[18-19]。有研究对使用手部功能训练 APP 的患者进行问卷调查,得出 APP 手机应用量表评分(mobile application rating scale, MARS)得分为 3.5 分(满分 5 分),表明该 APP 功能性较强^[20]。但目前康复训练 APPs 大多针对单独某一项功能训练,未来还需开发整合多种功能训练的综合 APPs,以便对患者进行全面康复训练。

1.2.2 慢性疼痛康复训练 慢性疼痛康复训练通常周期长,进展较慢,多数患者不会选择住院治疗。传统训练及理疗仅能缓解疼痛程度,但无法根治。有研究显示,APPs 辅助康复训练不仅可以通过视频指导、语言暗示及通知提醒等帮助慢性疼痛患者进行有氧运动、分级运动想象训练、音乐干预;还能根据每位患者的日常活动表现和功能进展调整其练习内容,为其制定个性化训练方案,减轻患者疼痛感,从而提高康复训练依从性,改善患者的生活质量。APPs 辅助康复训练具有成本低、时效长等优势,比传统康复训练更容易被患者接受,在临床慢性疼痛的治疗中具有应用价值^[21-26]。

1.2.3 平衡及步态训练 传统的平衡及步态训练多依赖于治疗师肉眼进行错误矫正,具有较强主观性,APPs 则可以通过传感器接收反馈指出错误,有效改善患者的平衡功能及步态。有研究显示,使用

运动游戏进行训练的远程康复组 Berg 量表评分改善情况显著高于对照组($P=0.019$)^[27]。通过 APPs 区分脑性瘫痪儿童动态马蹄足跖步步态的准确率也高达 95.3%^[28]。此外,APPs 与感应鞋垫传感器的结合还能改善帕金森病患者步速(1.11~1.21 m/s),利用传感器可以更加灵敏地反映患者的行为变化,及时反馈并提醒患者纠正步态,有助于达到更好的治疗效果^[29]。

1.2.4 认知心理功能训练 认知及心理功能障碍显著影响患者的社会参与能力,严重时还会威胁生命安全^[30]。传统的认知干预常常会使患者在面对陌生人时自尊心受创,产生更多心理问题,APPs 干预则能更好地保护患者的隐私。将 APPs 与移动设备的传感器相结合,对用户的认知状态进行长期远程的自动监测,并通过生活方式干预(如改善营养、加强认知功能锻炼)等新形式的认知训练可以维持甚至改善轻度认知障碍患者的认知功能、记忆力,预防老年痴呆症^[31-32]。有研究利用 APPs 提供的一系列游戏对老年人进行记忆力、注意力等认知功能刺激,并对其进行 6 个月追踪,发现老年人第 6 个月末的游戏成功率及游戏时间显著高于第 1 个月末,表明利用 APPs 认知功能刺激来提高老年人认知功能的可能性^[33]。此外,有关强迫症等心理障碍的患者通过 APPs 提供的每日简短认知训练进行练习也可以显著改善其相关症状^[34]。

利用 APPs 提供的积极正向性短信及电话等进行心理健康干预可以显著缓解心理功能障碍者抑郁和广泛性焦虑症状,减轻压力^[35]。通过 APP 干预创伤后应激症状及消极情绪也有一定积极作用;如 SPSRS 手机 APP 通过在视频中呈现积极文字可以帮助患者改善抑郁症状;IMHere(交互式移动健康系统)能够提醒脊髓损伤患者进行个人管理,促进患者与医疗团队的远程沟通,干预其抑郁情绪;Nintendo Wii 手机 APP 可以提高老年人的防跌倒意识,增强其预防跌倒的信心^[36-39]。APPs 数字化认知心理干预方便患者实时根据自己的需求定制专属指导或提示,与传统干预方式比较,APPs 具有成本低、易于患者访问等优势,还能更好地保护患者隐私,值得在临床中推广使用。

1.2.5 其他功能训练 APPs 在其他功能训练中也得到了广泛应用。如通过视觉反馈的形式辅助面瘫患者进行面部神经肌肉结构化训练,通过语音的形式治疗脑卒中患者的慢性失语症;利用视频帮助髌部骨折术后患者改善运动表现,提高心脏病患者

峰值摄氧量、肌肉耐力和肌力等^[40-43]。有研究表明,通过 APPs 提供的个性化节奏音乐帮助慢性阻塞性肺病患者进行步行训练可以显著减少其全身炎症反应、减轻呼吸困难症状^[44]。脊髓损伤患者通过 IMHere 的提醒进行居家护理可以显著预防尿路感染的发生^[38]。

综上,这些基于视觉反馈、动作矫正、语音提醒及远程指导等康复理念开发的 APPs 在传统康复训练的基础上对训练内容进行补充,创新了现有方案,增加治疗的趣味性,并帮助患者实现居家或社区康复训练的可能,减轻了患者医疗负担。同时,与传统康复训练比较,用 APPs 进行康复训练的患者功能改善程度、自我效能感和满意度无明显差别,表明 APPs 能够对功能受损的个体进行有价值的干预,并影响其作业表现^[17]。

1.3 APPs 在提高患者社会活动参与中的应用

1.3.1 辅助日常生活活动 互联网衍生的扩展应用可帮助生活不能自理的患者完成日常生活活动。肢体功能障碍者能够通过 APPs 订外卖、网上购物、预约家政等,无法使用电子设备的患者还可以通过 Siri、小度等语音助手进行操控。通过互联网数字提醒日历 APPs 为神经损伤患者系统地规划组织日常生活活动,可以改善作业表现及日常生活独立程度,减少其对照护者的依赖,减轻照料者及整个家庭的负担^[45]。但目前临床上还缺少与日常生活活动训练密切相关的 APPs,未来还需在此方面进行深入研究。

1.3.2 提高工作及学习参与能力 合理地利用 APPs 能够帮助功能障碍者进行有意义的工作和学习,提升患者的社会价值,促进其重返社会。如运动功能障碍者能够在 APPs 上进行短视频制作、金融理财、微商销售等工作,还可以通过 APPs 直播卖货获得可观的收入^[46]。此外,APPs 与互联网的结合还形成了一种新的教学生态环境,不能参加实体课堂的学生可以通过 APPs 远程上网课,也可以基于互联网的海量学习资源选择适合自己的学习内容和学习方式,促进功能障碍者的教育学习,对其实现自身社会价值将具有重要意义。

1.3.3 辅助娱乐休闲活动 功能障碍者还可以通过 APPs 完成娱乐休闲活动,如浏览视频、听音乐、玩游戏、查看新闻资讯以及和他人交流沟通等。对于因神经系统疾病、广泛性运动障碍和语言缺失等不能流畅使用电子设备的患者,研究者还开发了一种基于智能手机的数字化技术帮助其进行交流和休

闲活动^[47]。智力残疾、感觉或感觉运动障碍、视觉或视觉运动障碍以及听力障碍的患者都可以通过使用谷歌助手、MacroDroid 等辅助程序完成娱乐活动^[48-51]。APPs 帮助功能障碍者进行交流和休闲活动,满足了患者精神生活需求,并使其接触到海量信息,帮助患者应对不断发展的社会,防止其因功能障碍与社会脱节。

2 APPs 在康复领域应用中的优势

APPs 辅助康复在临床应用中呈现出了巨大优势。首先,通过 APPs 进行康复拓展了康复的场景,使康复不再局限于面对面进行,在居家、社区等多种场景中均可应用,不受时间、空间限制。其次,使用 APPs 进行评估不再需要复杂的工具和纸质版量表,通过移动互联网和手机即可方便地评估患者运动、认知、心理等功能情况,还能评估呼吸、脉搏、血氧饱和度等生理指标,降低治疗风险。此外,APPs 还可以使康复形式更加智能化、多元化,提高训练趣味性和患者的积极性。

3 小结与展望

APPs 在康复中的应用是多方位的,能够提高康复评定的便捷性,辅助改善患者的生理功能、心理功能,提高患者社会活动参与能力,促进患者功能障碍的全面恢复。与常规康复比较,APPs 辅助康复使康复治疗不再受时间、空间限制,使康复形式更加智能化、多元化,有助于解决康复行业目前面临的人员、机构及设备短缺问题,满足现代康复对养老服务个性化、多样化、多层次的需求,促进数字经济下我国智慧养老服务模式和产业的发展。

目前 APPs 在康复治疗的推广应用中还面临着许多困难。首先,APPs 普适性不强。老年人是存在功能障碍的主要人群,他们对电子设备使用不够熟悉,使用起来较困难^[52-53]。其次,APPs 功能较为单一,软件设计和使用不够规范。目前用于康复治疗的 APPs 大多针对某项单一功能或疾病,缺乏综合应用场景;同类型的 APPs 良莠不齐,种类繁多;康复治疗师未接受过专门的培训和学习等。因此,未来临床工作者还需要对互联网移动康复治疗这一新兴领域进行深入研究学习,寻找并开发适合不同功能障碍者的综合 APPs,并对患者提前进行应用培训,保证患者能够接受并积极配合使用电子设备辅助治疗。APPs 如何与康复结合以发挥各自的最大效能也是一个巨大挑战,未来应大力发展移动互联网

康复治疗,并提倡设立专门的治疗师岗位,以便通过 APPs 帮助患者进行全面有效的康复,发挥 APPs 辅助康复的最大功效,这对未来康复医疗的发展具有重要意义。

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Application of Mobile Internet Applications in Rehabilitation

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ABSTRACT The use of mobile internet applications (APPs) has become an indispensable part of daily life and has been applied in clinical rehabilitation. APPs assist rehabilitation to expand the rehabilitation scene. It makes rehabilitation assessment more simple and convenient, and makes trainings more intelligent and diversified. APPs-assisted rehabilitation has been applied in rehabilitation assessment, rehabilitation training and improvement of social activity participation. This review summarizes the application of APPs in rehabilitation field at home and abroad in order to maximize efficiency of the combination of APPs and rehabilitation training, and provide the evidence basis for further development of mobile internet rehabilitation services in the future. In rehabilitation assessment, APPs can be used to assist in the assessment of joint range of motion, balance and gait, speech and cognition, and psychological function. In rehabilitation training, APPs can be used to assist upper limb function training, chronic pain rehabilitation training, balance and gait training, cognitive psychological function training and other functional training. In the improvement of patients' participation in social activities, APPs can be used to assist activities of daily living, improve participation in work and study, and facilitate recreational activities. The application of APPs in rehabilitation can simplify the process of rehabilitation assessment and treatment, expand the scene of rehabilitation training, make the ways of rehabilitation more intelligent and diversified, improve the motivation and compliance of patients during training, and promote the rapid development of rehabilitation treatment. However, there are still many difficulties in the application of APPs in rehabilitation profession, such as lack of universal applicability, limited functions, and unstandardized software design and use. In the future, it is necessary to conduct research on the combination of internet mobile APPs and rehabilitation, to find and develop the comprehensive APPs suitable for people with different functional disabilities, in order to maximize efficiency of the APPs in assisting rehabilitation.

KEY WORDS mobile internet applications; rehabilitation therapy; rehabilitation assessment; rehabilitation training; intelligent rehabilitation

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Effect of Muscle Energy Technique Combined with Conventional Rehabilitation Therapy on Elderly Patients with Knee Osteoarthritis

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ABSTRACT **Objective:** To observe the effect of muscle energy technique combined with conventional rehabilitation therapy on elderly patients with knee osteoarthritis (KOA). **Methods:** A total of 84 patients with KOA in the rehabilitation medicine department of Shanghai Sixth People's Hospital from February 2021 to August 2022 were randomly divided into control group and observation group according to the random number sequence generated by SPSS 22.0 statistical software, with 42 cases in each group. During the course of treatment, two cases in the control group withdrew at the request, and a total of 82 cases were finally included, with 40 cases in the control group and 42 cases in the observation group. Both groups received conventional rehabilitation therapy (power bicycle and physical modality therapy), including power bicycle training for 20 min a time, and physical modality therapy of 15 min dynamic interferential electricity and 15 min ultrashort wave therapy each time, once a day, five days a week, lasting for four weeks. The observation group received muscle energy technique treatment on the basis of the control group, 30 minutes a time, once a day, five days a week, lasting for four weeks. Before treatment, after four weeks of treatment and at six months follow-up, the Western Ontario and Manchester Universities Osteoarthritis Indexes (WOMAC) was used to evaluate the degree of joint pain, joint stiffness and activities of daily living of patients with KOA. Before treatment and after four weeks of treatment, a goniometer was used to evaluate the range of motion (ROM) of the knee joint; the isokinetic muscle strength test and training system was used to evaluate quadriceps femoris muscle strength [quadriceps femoris peak torque (PT), quadriceps femoris peak torque to body weight ratio (PT/BW)]. **Results:** (1) WOMAC score: compared with that before treatment, the WOMAC joint pain, joint stiffness, activities of daily living score and total WOMAC score of the two groups decreased significantly after four weeks treatment and at six months follow-up ($P<0.05$). Compared with the control group at the same time, the WOMAC joint pain, joint stiffness, activity of daily living score and total WOMAC score in the observation group were significantly lower after four weeks treatment and at six months follow-up ($P<0.05$). (2) ROM, PT and PT/BW: compared with those before treatment, ROM, PT and PT/BW of both groups were significantly higher after four weeks treatment ($P<0.05$). Compared with the control group, ROM, PT and PT/BW in the observation group were significantly higher after four weeks treatment, and the differences were statistically significant ($P<0.05$). **Conclusion:** Muscle energy technique combined with conventional rehabilitation therapy can effectively relieve the pain and stiffness of knee joint of patients with KOA, and improve the range of motion of knee joint and quadriceps femoris muscle strength, which is recommended for clinical application.

KEY WORDS knee osteoarthritis; muscle energy technique; joint mobility; quadriceps femoris; muscle strength; elderly

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