墙报交流

探索基于生物反馈的人群分类在太极拳运动中的应用

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摘要：研究目的：后疫情时代，人们的生活方式和健康状况受到了深远影响，过去三年新冠疫情带来的心理及身体免疫等问题，需要我们长时间的关注与应对。太极拳作为一种具有悠久历史的中国传统武术，因其具有丰富的强身健体的效果，作为康复体育运动以及慢性疾病防治的辅助手段，受到青年群体、亚健康人群、慢病群体广泛关注。然而，年龄差异、个体差异和疾病特点的不同需要得到充分的考虑，并给予不同人群个体化的指导。生物反馈设备是一类能够监测人体生理指标，并将这些信息反馈给用户的设备。它们的发展得益于传感技术、数据处理和人工智能算法的进步，为人们提供了更准确、实时的生物信息反馈。这一生物反馈设备——细胞活力检测仪 (AURA)，由韩国人体科学研究所研发，获国际权威 USA. FAD ADMINISTRATIONN 认证的仪器设备，通过从手部向人体施加微弱的生物电流后检测和分析各器官和全身的细胞反应。目前在韩国 CHAUM 抗衰老中心及许多医院被用来做预防医学检查，仪器可以检测出被测者属于 7 种类型的某一种，根据相应类型的身体、心理健康状况给予饮食、运动、情绪压力管理的不同策略。在韩国很多大学也在使用该设备进行研究，如韩国首尔大学预防老年人痴呆症的心理咨询案例研究等。在中国，我们也在肿瘤患者细胞免疫治疗研究过程中验证了此设备使用的适用性和人群分类方法的准确性。我们希望引入次此设备探索此人群分类方法是不是适用于太极拳运动健身效果的研究，进而研究"体医结合"的具体实践方法，具有积极的现实价值和意义。**研究手段：**应学校公共体育太极拳教学"体医结合"研究的需求，将生物医学研究设备及研究人员引入体育教学与研究中，以 16 式简化太极拳为内容，以太极拳体育课堂为平台，选择年龄为 19-22 岁的大三学生为实验对象，采用生物反馈仪 (AURA) 及健康管理系统方法，共获取 230 人次的太极拳课程前、后的对比数据，对太极拳课堂上的大学生进行身体与情绪健康监测研究。即太极拳运动课前、课后分别进行检测，检测结果以不同色彩图像和量化的五行指数指标呈现，包括细胞活力指

数（Energy Level，EL）、身体活力与身体稳定度比值（Vigor/Stability，V/S）、五行指数（Balance Diagram）；以及会给出相应的运动、饮食、情绪调节的方法建议。指标原始数据使用 SPSS Statistics 软件对其进行统计学处理分析。**研究结果：**根据细胞活力检测仪的标准，适当的活力度和稳定度的比例（V/S）是 60:40，年轻人的比值到 70:30 也可视为比较协调，50:50 以下表示身体处于细胞活力低下的状态，需要补充能量；70:30 以上，表示身体处于非常高的压力状态，细胞因毒素变得非常敏感。本文中定义 V/S 比例在 50:50—70:30 为Ⅰ型（A 组），V/S 比例 50:50 以下为Ⅱ型（50:50 以下的 B 组和 40:60 以下的 C 组），比例70:30 以上为Ⅲ型（比例 70:30 以上的 D 组和 80:20 以上的 E 组）。我们对太极拳课程受试同学们的仪器检测测试结果：（1）太极拳运动受试同学们可大致分为这三个类型。Ⅰ型（A组）：属于活力度比较协调的状态。根据生物反馈仪大数据反馈对不同人群的健康建议，以及在我们医学工作实践中的经验，此类同学建议多摄入维生素 A 和 B 族含量高的蔬菜类，钙含量高的食品，调节呼吸非常重要，建议进行徒步、登山、舞蹈、羽毛球、深呼吸等管理压力的运动措施。减少说话、在做出行动前再三考虑。Ⅱ型（B、C 组）：他们处于此细胞活力状态下的这一部分同学们，作为年轻人属于细胞反应低下，此类同学，结合医学健康常识，建议多摄入高蛋白类的食物（肉类、鱼类、豆类），不要摄取过多的糖分，学习开放的思维，多进行上半身增强运动，健美操、乒乓球等；不要担任过多的业务，与他人更多的交流沟通。Ⅲ型（D、E 组）：这部分同学身体处于亢奋的状态，细胞容易疲劳，对内外压力做出过于敏感的反应，根据"体医结合"教学实践研究，此类同学需多摄入新鲜的蔬菜水果、杂粮、鱼类、海藻类、蘑菇类，稳定和放松身心的措施会很有用，建议进行冥想、放松训练、散步、森林浴等活动；不急不燥，听取他人的意见。（2）基于细胞活力水平的人群分类比例，符合当下大学生的身体机能的人群分布状况。通过太极拳课程中细胞活力仪的检测结果显示，在实验对象 230 人中，Ⅰ型的 A 组为 121 人（54.50%），Ⅱ型中 B 组 39 人（17.57%），尤其是活力度过低的 40:60 以下（C 组）的有 23 人（10.36%）。而Ⅲ型中 D 组的为 70 人（31.53%），尤其是活力度过高的 80:20 以上（E 组）的为 43 人（19.37%），体现出了学习优秀的清华学生群体在智力、体力、健康方面的发展，仍然呈现出了正态分布的规律，对于他们健身、健康体育促进发展，要重视抓两头、促中间的措施手段。细胞活力状态协调的Ⅰ型（A 组）占比超过 50%，说明大部分同呈现出充满活力的年轻人状态。细胞活力状态低弱的Ⅱ型中，B 组对内外压力的反应比较低弱，肺部支气管、循环系统失去活力、多属于操心担忧、效能低的同学，尤其是活力度过低的 C 组同学，容易出现失望的情绪、抑郁、大脑功能变弱的问题，需要引起关注。细胞活力状态过高的Ⅲ型中 D 组比例是Ⅱ型中 B 组的 2 倍左右，多

数则为压力大的同学，体现了当下大三学生处于压力较大的状态。这部分同学肠胃功能容易变敏感，颈部、肩部肌肉容易出现僵硬，要注意内分泌系统、便秘，尤其是 E 组，长期处于此种状态容易导致过劳、心脑血管问题发生，更需要缓慢、柔和的太极拳运动作为运动健身或恢复的干预手段。 （3）细胞活力水平较低的Ⅱ型通过太极拳运动提升活力效果显著，身体活力与身体稳定性比值（V/S）提升显著，趋于协调。通过仪器检测试验，表明了受试同学们其太极拳练习前、后细胞活力指标数值变化的规律。B 组由 323.15 提高至太极拳运动后的 463.33，提升 43.38%，C 组由 258.52 提高至太极拳运动后的 455.70，显著提升 76.27%，这种变化在统计学上具有显著性变化意义。可见，对于Ⅱ型群体，细胞活力较弱的 B 组，尤其是容易产生抑郁的 C 组，太极拳运动对机体细胞的激活效果非常明显，显著提升细胞的反应能力。此外，受试同学 B 组太极拳前的身体活力与身体稳定度比值(V/S)为 34.15:62.43，C 组为 25.91:70.78,而在太极拳课程后分别提升显著，B 组为 52.26:44.44，C 组为 51.39:45，均从远低于 50:50 的水平提升到超过 50:50 的身体活力与身体稳定度的比例值，向着趋于更加适合和较协调的水平积极地调整与完善。由此，可以看到太极拳课程虽然短短的一节太极拳运动课，但对于抑制型弱态型同学的健身、健康具有显著意义的影响价值。 （4）细胞活力水平协调和较高的Ⅰ型、Ⅲ型通过太极拳运动提升活力效果较弱，身体活力与身体稳定性平衡的比值变化不大。Ⅰ型（A 组）A 组同学本身细胞活力水平就较为平衡，太极拳后变化不大，仍在协调范围内，但是五行平衡偏差值显著降低。五行指数愈趋向于一致，表示身体脏腑功能愈加平衡。协调型 A 组同学心（火）与肝（木）差值、心（火）与脾（土）、心（火）与肺（金）、心（火）与肾（水）差值分别由太极拳课程前的 20.66、17.35、17.09、19.17 降低为 12.50、13.90、13.93、14.43；均由需要非常注意进行管理等级降低了一个等级，为需要进行管理等级。肝（木）指数经过太极拳课程后变化最大，最终达到五行平衡的理想状态。而Ⅲ型的 D 组太极前细胞能量水平值由 699.25 提高至太极拳运动后的 767.51，增加 9.76%；E 组由 739.51 提高至太极拳运动后的 780.88，增加 5.59%，变化不大。而身体活力与身体稳定度比值（V/S）的变化情况，在太极前 D 组为 82.8:14.59，E 组则是 88.16:9.84，而 D 组在太极后为 91.00:8.15，E 组为 92.33:7.72，其二者比值变化不大。兴奋型的 D、E 组同学们其本身活力度较高，身体稳定度即与身体活力度相制约的生理的、机能的抑制度很低。即身体活力与身体稳定度失衡比值远超过了理想标准范围。结果提示兴奋型群体短时间学习太极拳，可能对"气"的理解把握还有难度，教师需要从教学方法、心理暗示或诱导进行更深入探索实践，而学生需要反复、熟练练习，并在太极拳蕴含的传统文化思想理念上加强理解与学习。**研究结论**：本研究探讨了基于生物反馈的人群分类在太极拳运动中的应用， （1）

生物反馈设备提供的人群分类帮助同学们更科学的了解自己的身心平衡状态, 是"体医结合"模式的一种具体实践方式。同时, 根据细胞活力检测仪 (AURA) 检测到的相应类型的身体、心理健康状况信息, 医学研究人员能够给同学们提供饮食、运动、情绪压力管理的不同策略指导, 增强了同学们的健康管理意识, 提高了健康认知水平, 对自我身体和心理的和谐发展更加重视。 (2) 通过使用生物反馈仪对学生太极拳运动受试者进行检测和对比分析, 基于细胞活力水平的精准化人群分类方法, 也在太极拳运动健身效果中得到了验证。尤其发现了太极拳运动健身的个性化健身、健康调整、完善、提高的作用, 即对于细胞活力水平较低的Ⅱ型群体, 以及五行平衡偏差较大的人群, 太极拳运动前后表现出精准化健身调节的显著性的变化, 表明了太极拳运动作为一种个体化、精准化健身运动的特色效果。 (3) 通过细胞活力仪检测参与太极拳课程教学研究, 结合体育组老师多年太极拳教学研究的实践效果, 基于生物反馈的人群分类, 也帮助教学老师更好的了解学生的身体、心理状态, 利于开展个体化的教学指导, 体现"体医结合"模式对太极拳体育教学老师的辅助意义。此外, 本研究也为"体医结合"模式下的太极拳运动在其他人群中的探索提供了示范。

关键词：体医结合；太极拳；生物反馈；人群分类；个体化

Exploring the Application of Biofeedback-based Population Classification in Tai Chi Exercise

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Abstract：**Research Purpose:** In the post-pandemic era, people's lifestyles and health conditions have been profoundly affected. The psychological and physical immune issues caused by the COVID-19 pandemic in the past three years require long-term attention and intervention. Tai Chi, as a traditional Chinese martial art with a long history, has gained widespread attention as a rehabilitation exercise and an adjunctive approach for chronic disease prevention and management due to its beneficial effects on physical fitness. However, it is necessary to consider age differences, individual differences, and disease characteristics, and provide personalized guidance for different populations.

Biofeedback devices are a type of equipment that can monitor physiological indicators and provide feedback to users. Their development has benefited from advancements in sensing technology, data processing, and artificial intelligence algorithms, allowing for more accurate and real-time biofeedback. The Cell Vitality Detection Instrument (AURA), developed by the Korean Institute of Human Science, is one such biofeedback device. It has obtained international certification from the USA. FDA Administration and detects and analyzes cellular reactions in various organs and the whole body by applying weak bioelectric currents to the hands. Currently, it is used for preventive medical examinations at the CHAUM Anti-Aging Center and many hospitals in Korea. The instrument can classify individuals into one of seven types and provide different strategies for diet, exercise, and stress management based on the corresponding type's physical and psychological health status. Many universities in Korea are also using this device for research, such as Seoul National University's case study on psychological counseling for preventing dementia in the elderly. In China, we have verified the applicability and accuracy of the device's population classification method in the research process of cellular immunotherapy for cancer patients. We hope to introduce this device to explore whether this population classification method is applicable to the study of the effects of Tai Chi exercise on physical fitness. Furthermore, we aim to investigate specific practical methods for integrating "sports and medicine," which has positive practical value and significance.

Research Methods: To meet the needs of the school's research on the integration of "sports and medicine" in public physical education Tai Chi teaching, biomedical research equipment and researchers were introduced into physical education teaching and research. Using the 16-form simplified Tai Chi as the content and the Tai Chi physical education class as the platform, we selected third-year college students aged 19-22 as the experimental subjects. The biofeedback device (AURA) and health management system were used to obtain comparative data before and after Tai Chi classes, with a total of 230 data points. The study focused on monitoring the physical and emotional health of college students in Tai Chi classes. The measurements were conducted before and after Tai Chi exercise sessions, and the results were presented in different colored images and quantified Five Elements Index indicators, including Energy Level (EL), Vigor/Stability (V/S) ratio, and Balance Diagram. The system also provided corresponding exercise, diet, and emotion regulation recommendations. The raw data were analyzed using SPSS

Statistics software for statistical analysis.

Research Results: According to the standards of the cellular vitality detection device, an appropriate ratio of vitality and stability (V/S) is 60:40, and a ratio of 70:30 can be considered relatively balanced for young people. A ratio below 50:50 indicates low cellular vitality and the need for energy supplementation, while a ratio above 70:30 indicates a high-stress state where cells become very sensitive to toxins. In this study, we defined V/S ratios between 50:50 and 70:30 as Type I (Group A), ratios below 50:50 as Type II (Group B with ratios below 50:50 and Group C with ratios below 40:60), and ratios above 70:30 as Type III (Group D with ratios above 70:30 and Group E with ratios above 80:20).

(1)Based on the instrument test results of the participants in the Tai Chi class, they can be roughly categorized into these three types:

Type I (Group A): These participants are in a relatively balanced state of vitality. According to the feedback from the biometric device and our experience in medical practice, it is recommended for these individuals to consume more vegetables with high vitamin A and B content, foods high in calcium, and to focus on regulating their breathing. Recommended stress management exercises include hiking, mountain climbing, dancing, badminton, and deep breathing. They should also reduce excessive talking and carefully consider actions before taking them.

Type II (Groups B and C): These participants are in a state of low cellular response, which is typical for young people. For these individuals, it is recommended to consume more protein-rich foods (meat, fish, beans) and avoid excessive sugar intake. They should adopt an open mindset and engage in upper body strengthening exercises such as aerobics and table tennis. It is also beneficial for them to reduce excessive workloads and increase communication and interaction with others.

Type III (Groups D and E): These participants are in an overexcited state, and their cells are prone to fatigue and hypersensitive reactions to internal and external pressures. Based on the "integration of medicine and physical fitness" teaching practice, it is recommended for these individuals to consume more fresh fruits, vegetables, whole grains, fish, seaweed, and mushrooms. Measures to stabilize and relax the body and mind, such as meditation, relaxation training, walking, and forest bathing, are highly recommended. They should also avoid impatience and listen to the opinions of others.

(2) The distribution of the population based on the level of cellular vitality aligns with the current physical function of college students. According to the results of the cellular vitality monitor in the Tai Chi course, out of the 230 participants, 121 individuals (54.50%) belong to Type I, with Group A comprising the majority. In Type II, Group B consists of 39 individuals (17.57%), and particularly, there are 23 individuals (10.36%) in Group C with extremely low vitality levels below 40:60. In Type III, there are 70 individuals (31.53%) in Group D, and notably, 43 individuals (19.37%) in Group E have excessively high vitality levels above 80:20. This distribution reflects the development of intellectual, physical, and health aspects among the outstanding students at Tsinghua University, while still following the pattern of a normal distribution. It is important to focus on measures that promote fitness and health for both ends of the spectrum and encourage balance in the middle. The fact that over 50% of the participants fall into the Type I category (Group A) indicates that most of the students exhibit a vibrant and energetic state. In Type II, Group B represents individuals with low reactivity to internal and external pressures, often experiencing diminished vitality in the respiratory and circulatory systems. These students tend to worry excessively and have low efficiency. Especially in Group C, where vitality levels are extremely low, individuals are prone to feelings of disappointment, depression, and reduced brain function, which require attention. In Type III, the proportion of Group D, which represents individuals with excessively high vitality levels, is approximately twice that of Group B in Type II. Most of these students experience high levels of stress, and they are more likely to have sensitive gastrointestinal functions, stiff neck and shoulder muscles, and issues related to the endocrine system and constipation. Particularly in Group E, prolonged exposure to this state can lead to overwork and cardiovascular and cerebrovascular problems, making it even more important to incorporate slow, gentle Tai Chi exercises as a means of physical exercise and recovery intervention.

(3) Type II individuals with low cellular vitality show significant improvement in vitality through Tai Chi exercises, with a significant increase in the ratio of physical vitality to physical stability (V/S), moving towards a more balanced state. The experimental results of the instrument tests indicate the pattern of changes in cellular vitality indicators before and after Tai Chi practice among the participants. In Group B, the cellular vitality increased from 323.15 to 463.33 after Tai Chi exercises, a significant improvement of 43.38%. In Group C, which is prone to depression, the

cellular vitality increased from 258.52 to 455.70 after Tai Chi exercises, showing a significant improvement of 76.27%. These changes have statistical significance. This indicates that for Type II individuals, especially those in Group B with weak cellular vitality and Group C prone to depression, Tai Chi exercises have a significant activating effect on cellular responses, significantly enhancing the body's ability to react. Additionally, the ratio of physical vitality to physical stability (V/S) before Tai Chi exercises in Group B was 34.15:62.43, and in Group C it was 25.91:70.78. After the Tai Chi course, both groups showed significant improvement, with Group B at 52.26:44.44 and Group C at 51.39:45. These ratios shifted from levels far below 50:50 to proportions exceeding 50:50, indicating a positive adjustment and improvement towards a more suitable and balanced level of physical vitality and stability. Therefore, even a single Tai Chi exercise class has significant value and impact on the fitness and health of individuals with inhibitory and weak tendencies.

(4)Type I individuals with a relatively balanced level of cellular vitality, and Type III individuals with higher cell vitality showed little change in the balance between body vitality and stability after practicing Tai Chi. In Type I individuals (Group A), their cellular vitality levels were already balanced, and there was little change after practicing Tai Chi, remaining within the range of coordination. However, there was a significant decrease in the deviation of the Five Elements balance index. The closer the Five Elements index is to consistency, the more balanced the body's organ functions are. The differences between the heart (fire) and liver (wood), heart (fire) and spleen (earth), heart (fire) and lungs (metal), and heart (fire) and kidneys (water) decreased from 20.66, 17.35, 17.09, and 19.17 before Tai Chi to 12.50, 13.90, 13.93, and 14.43 after Tai Chi. The management level required for these differences decreased by one level, indicating a need for management. The liver (wood) index showed the largest change after Tai Chi, reaching the ideal state of Five Elements balance.

In Type III individuals, the D group's cellular energy level increased from 699.25 to 767.51 after Tai Chi, an increase of 9.76%. The E group increased from 739.51 to 780.88 after Tai Chi, a small increase of 5.59%. The ratio of body vitality to body stability (V/S) did not change significantly. For the D group, the ratio before Tai Chi was 82.8:14.59, and for the E group, it was 88.16:9.84. After Tai Chi, the ratio for the D group was 91.00:8.15, and for the E group, it was 92.33:7.72. The imbalance between body vitality and body stability ratio still exceeded the ideal range. This

suggests that Type III individuals with high excitability may have difficulty understanding the concept of "qi" and that teachers need to explore teaching methods, psychological suggestions, or inductions to a greater extent. Students need to practice repeatedly and gain a better understanding of the traditional cultural concepts and ideas embedded in Tai Chi.

Conclusion: This study explored the application of biofeedback-based population classification in Tai Chi exercise. Firstly, the biofeedback device provided population classification, helping students understand their physical and mental balance in a more scientific way. It is a specific practice of the "integration of Sports and medicine" model. Secondly, the study verified the effectiveness of personalized fitness and health adjustment through Tai Chi exercise by using the biofeedback device to detect and compare student participants. Especially for Type II individuals with low cellular vitality and individuals with significant deviations in Five Elements balance, Tai Chi exercise showed significant changes in personalized fitness regulation, highlighting the characteristic effects of Tai Chi as an individualized and precise fitness exercise. Thirdly, the use of the biofeedback device in Tai Chi teaching and research, combined with the practical effects of physical education teachers' years of Tai Chi teaching research, helped teachers better understand the physical and mental states of students and facilitate individualized teaching guidance, reflecting the auxiliary significance of the "integration of Sports and medicine" model for Tai Chi physical education teachers. Additionally, this study provides a demonstration for the exploration of Tai Chi exercise in other populations under the "integration of Sports and medicine" model.

Keywords: Integration of Sports and Medicine, Tai Chi, Biofeedback, Population Classification, Individualization