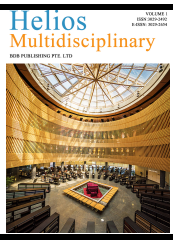
Helios Multidisciplinary

Journal homepage: http://www.bdbpublishinghelios.com/
ISSN: 3029-2492, E-ISSN:3029-2654



Precision Exercise Support for University Students: A Scoping Review of Assessment, Prescription, Monitoring, Feedback, and Adaptation

Wenshan Du[1], Yingsoon Goh[2*]

[1] Department of Physical Education, Hainan Medical University, No. 3 Xueyuan Road, Longhua District, Haikou City, Hainan Province 571199, China

[2] Nilai University, Persiaran Universiti, Putra Nilai, 1, Persiaran Kolej Bbn, 71800 Nilai, Negeri Sembilan, Malaysia

ARTICLE INFO

Article history:

RECEIVED 21 August 2026
ACCEPTED 20 September 2026
PUBLISHED 12 October 2026

Keywords:

university students; physical fitness; precision exercise; exercise prescription; physical education; wearable technology; scoping review

ABSTRACT

Objective: To map how exercise and physical-education research with university students has implemented assessment, subgroup targeting, individualized prescription, monitoring, feedback, and response-based adjustment, and to identify what is still required for a reproducible closed-loop precision-support system. Methods: This scoping review followed JBI guidance and the PRISMA extension for scoping reviews. PubMed, Scopus, and CINAHL Ultimate were searched on August 21, 2026, for English-language studies, supplemented by an existing 28-report full-text seed set. Eligible studies involved university students and evaluated an exercise, physical-education, fitness-testing, monitoring, or feedback component relevant to tailoring exercise support. A five-level framework was applied: standardized provision (level 0), subgroup targeting (level 1), assessment- or feedback-informed adaptation (level 2), individual prescription (level 3), and response-adaptive closed loop (level 4). Results: The searches and seed set identified 403 records; 358 unique records were screened, 48 reports were assessed in full text, and 30 studies entered the evidence map. Fifteen studies used standardized provision, three targeted a predefined subgroup, six implemented assessment, monitoring, or personalized feedback without a complete individual prescription, and six reported individual exercise prescriptions. No study fully specified a level-4 closed loop with prospective monitoring variables, decision thresholds, and reproducible rules for changing frequency, intensity, time, or type. Exercise programs improved selected fitness, body-composition, physical-activity, and mental-health outcomes, but effects were outcome-specific and heterogeneous. Wearables and mobile platforms made monitoring scalable, yet fixed goals, multicomponent designs, and limited use of monitored data for treatment decisions constrained personalization. Assessment feedback could also reduce competence and intrinsic motivation when interpreted negatively. Conclusions: The literature has progressed beyond uniform exercise delivery, but digital monitoring should not be equated with precision. A defensible university model requires an auditable chain from multidimensional assessment to stratification, FITT prescription, process monitoring, interpretable feedback, and threshold-based adjustment, alongside evaluation of safety, equity, adherence, teacher workload, and operational efficiency.

1. Introduction

University is a transitional period in which structured school routines give way to greater

* *Corresponding author: Yingsoon Goh*
Email address: drysgoh@nilai.edu.my

https://doi.org/10.70702/bdb/CBWR1793

personal control over time, movement, diet, and sleep. Physical activity often declines during this period, while sedentary behavior, weight-related risk, and psychological stress may increase. Longitudinal and surveillance studies from Chinese universities have reported unfavorable trends or marked subgroup differences in health-related fitness (Dong et al., 2023; Sun et al., 2025). Exercise behavior is also shaped by interacting individual, interpersonal, environmental, and institutional factors (Pan et al., 2022). A uniform physical-education course or a single fitness target is therefore unlikely to be equally appropriate, acceptable, and effective for all students.

Universities increasingly use digital fitness-testing systems, mobile applications, and wearable devices. These technologies can reduce manual recording, provide rapid feedback, and extend monitoring beyond scheduled classes. Nevertheless, technology alone does not make an intervention precise. A wearable can count steps while assigning the same target to everyone; a fitness test can generate individualized scores without changing the subsequent exercise program; and an application can deliver reminders without explaining how recorded responses alter the prescription. Precision therefore concerns the decision process rather than the device. At minimum, student characteristics and measured responses should have a traceable influence on the frequency, intensity, time, or type of exercise that follows.

The broader university exercise literature has established that multiple programs can improve selected outcomes. Randomized trials of Baduanjin and Tai Chi have reported improvements in flexibility, cardiorespiratory endurance, balance, proprioception, and selected psychological outcomes, although several prespecified outcomes were null (Li et al., 2015; Ye et al., 2022; Zheng et al., 2015). Mandatory classes and Sport Education have also been associated with fitness, motivation, physical literacy, or lesson activity (Bao et al., 2020; Choi et al., 2021, 2024). More recent trials have examined blended learning and functional training (Li, Meng, et al., 2025; Wang, Yuan, & Ji, 2024). This literature identifies useful exercise and teaching options, but it does not by itself show which option should be assigned to a particular student, how the starting dose should be selected, or when the program should change.

Several newer studies move closer to those questions. Individual aerobic or resistance prescriptions have been tested in students with depressive symptoms (Zhao et al., 2023). Functional movement screening has informed corrective training and prescription-based health education (Li, Su, et al., 2025; Zhang et al., 2024). Mobile and wearable systems have combined activity monitoring with goals, coaching, social comparison, or gamification (Al-Nawaiseh et al., 2022; Pope et al., 2019; Xu et al., 2021; Yang et al., 2026). Terminology remains inconsistent: studies described as tailored or personalized differ in what they measure, which decisions are individualized, and whether adaptation continues after the program begins.

A scoping review is appropriate when a field has heterogeneous designs, variable terminology, and a need to clarify concepts and identify evidence gaps rather than estimate a single pooled effect (Peters et al., 2024). The present review therefore examined exercise interventions, physical-education models, fitness assessment, monitoring, and feedback as parts of a potential precision-support pathway for university students. The review asked four questions: What populations, designs, delivery modes, and outcomes have been studied? Which elements of assessment, stratification, prescription, monitoring, feedback, and adjustment have been implemented? How far have studies progressed from standardized provision toward individual and response-adaptive support? What methodological and organizational evidence is required for a scalable university closed loop?

2. Methods

2.1 Design and reporting framework

The review was conducted using the JBI approach to scoping reviews and reported in accordance with PRISMA-ScR (Peters et al., 2024; Tricco et al., 2018). The purpose was to map concepts, implementation features, and evidence gaps. Because populations, interventions, outcomes, and designs were highly heterogeneous, meta-analysis was not planned. The review did not have a prospectively registered protocol; this is acknowledged as a limitation.

2.2 Eligibility criteria

Eligibility was structured using the population–concept–context framework. The population included university, college, and undergraduate students, including predefined subgroups such as sedentary students, students with overweight or obesity, students with mental-health symptoms, and students with functional limitations. The concept encompassed exercise or physical-education provision and any component capable of supporting differentiation: assessment, risk or need stratification, exercise prescription, monitoring, feedback, goal setting, coaching, or progression. The context included curricular physical education, campus health promotion, student health services, home-based programs linked to a university sample, and digitally supported exercise. Primary quantitative, qualitative, mixed-methods, feasibility, and modeling studies were eligible when they evaluated an intervention or a directly relevant precision-support component. Reviews, policy documents, population trends, purely correlational digital-use studies, and school-age surveillance frameworks were retained only as contextual references and were excluded from the core evidence map.

Table 1

Eligibility criteria based on the PCC framework

	Domain	Included	Excluded
	Population	University, college, or undergraduate students; clearly defined student subgroups	Samples in which university students could not be separated; elite athletes as the sole target; nonstudent clinical populations
	Concept	Exercise, physical education, fitness assessment, subgroup targeting, individual prescription, monitoring, feedback, coaching, or adaptation	General health education without an exercise component; technology-use intention without intervention or feedback evaluation
	Context	University courses, campus programs, student health services, or university-linked home/digital programs	Primary or secondary school surveillance; workplace or community programs without a university-student sample
type	Evidence	Primary intervention, implementation, feasibility, qualitative, or validation/modeling study relevant to precision support	Review, meta-analysis, policy, commentary, protocol without results, or insufficient conference abstract
and dates	Language	English-language records; database searches limited to 2010–2026	Non-English records in the supplementary database search

2.3 Information sources and search strategy

PubMed, Scopus, and CINAHL Ultimate were searched through institutional access on August 21, 2026. PubMed used four complementary searches covering personalized or prescribed exercise, digital monitoring and feedback, physical-fitness interventions, and differentiated physical education. The four searches returned 45, 99, 88, and 2 records, respectively, for 234 records before within-database deduplication and 230 unique PubMed records. Scopus returned 133 records after limiting the search to English. CINAHL Ultimate returned eight English-language, peer-reviewed research records after full-text, research-article, and 2016–2026 filters. An existing seed

set of 28 full-text reports from a topic-specific Zotero collection was added to reduce the risk that relevant physical-education and contextual studies not captured by precision terminology would be missed.

The Scopus search combined student terms with personalized, individualized, tailored, prescribed, monitored, feedback-supported, or adaptive exercise and physical education. The CINAHL search combined university-student terms, physical fitness or exercise terms, and personalized, stratified, prescribed, wearable, monitoring, or feedback terms. Complete PubMed strings and a database audit are retained in the review folder. No Chinese-language database was used in this supplementary search.

2.4 Record selection

The sources produced 403 records: 375 from databases and 28 from the seed set. Title normalization and exact deduplication removed 45 repeated records, including four repeated PubMed hits and 41 cross-source duplicates. One reviewer screened 358 unique titles and abstracts against the PCC criteria. Uncertain records were retained conservatively. Forty-eight reports were retrieved in full text and assessed; none of the sought reports was unavailable. Eighteen reports were excluded from the core map: five secondary syntheses, 10 contextual, mechanism, measurement, or trend studies without an eligible intervention or test-feedback component, one policy document, and two surveillance sources outside the university population. Thirty studies were included. All record-level and full-text decisions were retained in audit tables.

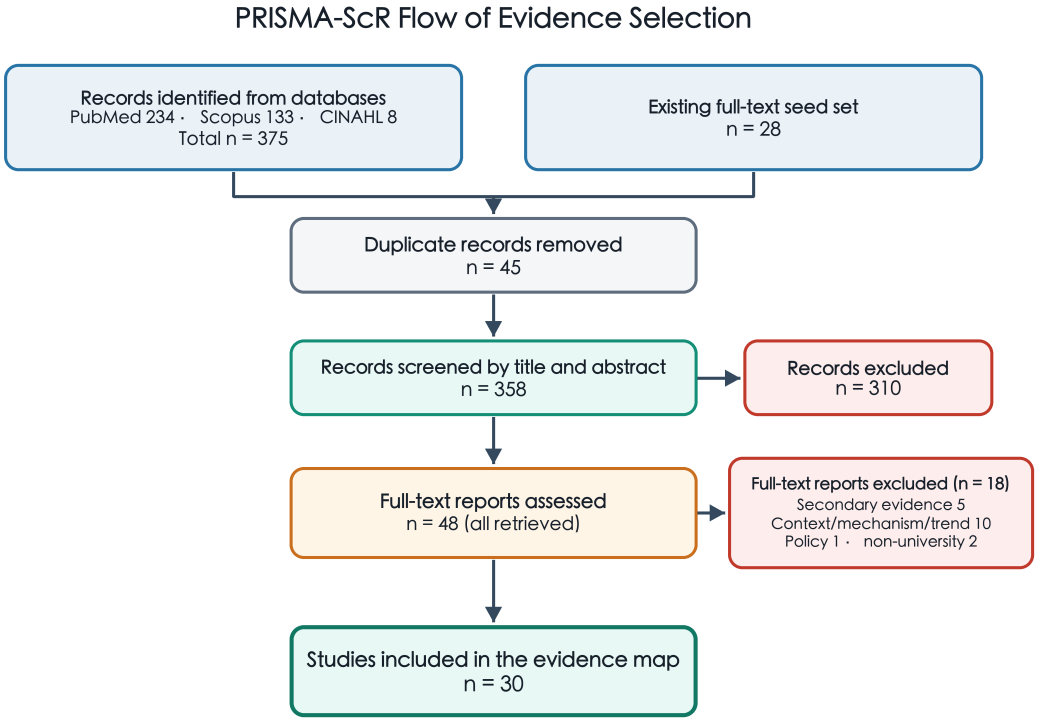


Figure 1. PRISMA-ScR flow of evidence selection.

2.5 Data charting

For each included study, data were charted on country or setting, design, sample, target population, exercise or teaching content, frequency–intensity–time–type parameters, comparator, assessment inputs, subgroup or matching rule, monitoring, feedback, progression, outcomes,

principal findings, and limitations. Full-text PDFs were converted to page-delimited Markdown to support searchable evidence checking, while the original PDFs were retained for verification. Numerical claims used in the synthesis were checked against the article abstract, tables, or results text rather than inferred from titles.

2.6 Precision-support framework

A five-level framework was developed to distinguish the presence of technology or testing from actual decision-level personalization. Level 0 represented standardized provision, in which participants received essentially the same program or target. Level 1 represented subgroup targeting, in which eligibility was based on a shared characteristic but the subgroup received a common program. Level 2 represented assessment-, monitoring-, or feedback-informed adaptation that individualized information or calibration without specifying a complete individual FITT prescription. Level 3 represented an individual exercise prescription or pattern-specific program in which exercise content or dose was assigned at the participant level. Level 4 required a response-adaptive closed loop: prospectively defined monitoring variables, decision thresholds, and reproducible rules for changing FITT parameters during the intervention.

Table 2

Operational definition of precision-support levels

Level	Label	Minimum evidence required	Example distinction
0	Standardized provision	Common course, exercise dose, or behavioral target	A single 10,000-step target delivered to all participants
1	Subgroup targeting	Entry based on a shared need or risk characteristic	One fixed program for sedentary women or students with obesity
2	Assessment/feedback adaptation	Individual calibration, monitoring display, personalized prompt, or feedback linked to measured data	Heart-rate-reserve feedback or personalized progress prompts without a complete individual FITT plan
3	Individual prescription	Participant-level exercise selection or dose based on assessment, goals, symptoms, or movement patterns	FMS-guided corrective exercise or individualized aerobic/resistance prescription
4	Response-adaptive closed loop	Continuous or periodic monitoring plus explicit thresholds and rules that alter FITT during treatment	Intensity increased when adherence and exertion criteria are met and reduced when symptoms cross a safety threshold

Two distinctions were applied consistently. First, using an application or wearable did not raise the precision level unless the collected information changed calibration, feedback, or prescription. Second, repeated measurement did not qualify as level 4 unless the study reported how new data triggered a training decision.

2.7 Synthesis

Studies were summarized descriptively by precision level, target population, intervention type, digital component, and outcome domain. Findings were synthesized thematically around standardized and subgroup-targeted exercise, assessment and individual prescription, monitoring and digital feedback, motivational and implementation effects, and the completeness of the closed loop. Results were not pooled because intervention content, duration, outcome measurement, and designs were not sufficiently comparable.

3. Results

3.1 Study selection and distribution

Thirty studies entered the evidence map. Publication years ranged from 2015 to 2026, with a marked concentration after 2021. Most studies were conducted in mainland China or Hong Kong, although evidence also came from the United States, Jordan, Norway, Türkiye, and Malaysia. Randomized and controlled trials predominated, but the map also included longitudinal classroom observation, qualitative implementation research, feasibility pilots, retrospective dose–response analysis, and a sensing-model validation study. Samples ranged from 13 students in a tailored mental-health exercise pilot to 10,905 longitudinal fitness-test records in a university physical-education study.

The precision distribution was strongly skewed toward lower levels. Fifteen studies were coded level 0, three level 1, six level 2, and six level 3. No study met level 4. Thus, half of the included literature tested a common program or goal, while only one fifth clearly assigned an individual exercise prescription. Monitoring and feedback were increasingly common, but monitored data usually described adherence or outcomes rather than triggering a prespecified change to training.

Table 3

Summary of the 30 included studies by precision-support level

Study	Design/sample	Intervention or component	Precision level	Main contribution
Ye et al. (2022)	RCT; n=130	Baduanjin, 12 weeks	0	Improved composite fitness and selected components
Wang, Zhang, and Wu (2024)	Randomized trial; n=93	Baduanjin for sports-disadvantaged students	1	Demonstrated a subgroup-targeted alternative
Bao et al. (2020)	Longitudinal records; n=10,905	Mandatory PE, 2 h/week	0	Linked curricular exposure with fitness-test scores
Li et al. (2015)	RCT; n=222	Baduanjin, 12 weeks	0	Improved selected physical and attention outcomes
Zheng et al. (2015)	RCT; n=206 recruited	Tai Chi, 12 weeks	0	Improved flexibility and balance, with several null outcomes
Wang and Ali (2023)	Quasi-experiment; n=289 completers	Short Tai Chi course	0	Supported acceptability rather than fitness efficacy
Choi et al. (2021)	Observation; 202 students, 156 lessons	Sport Education	0	Identified lesson structures associated with activity
Choi et al. (2024)	Longitudinal mediation; n=188	Sport Education	0	Linked motivation and physical literacy to daily activity
Choi et al. (2022)	Qualitative implementation study	Teacher development and Sport Education	0	Identified teacher and context implementation requirements
Zhao et al. (2023)	Three-arm RCT; n=86	Individual aerobic/resistance prescriptions	3	Demonstrated individualized prescription for depressive symptoms
Li et al. (2026)	Three-arm RCT; n=63	1v1 or 3v3 basketball for sedentary women	1	Improved fitness and adiposity in a targeted subgroup
Chandler et al. (2021)	Quasi-experiment; n=430	Individual fitness-test feedback	2	Showed that negatively perceived feedback can reduce motivation
Kundakcı et al. (2023)	Comparative pilot; n=25	Smart step board, heart-rate strap, and app	2	Demonstrated calibrated real-time intensity feedback

Study	Design/sample	Intervention or component	Precision level	Main contribution
Pope et al. (2019)	Randomized pilot; n=38	Smartwatch plus social-media education	0	Demonstrated feasibility but limited comparative effects
Xu et al. (2021)	Two longitudinal studies	WeChat self-monitoring and social norms	0	Found sex-specific and possible backfire effects
Al-Nawaiseh et al. (2022)	RCT; n=130	App with fixed 10,000-step goal	0	Increased steps and improved body weight
Zhong et al. (2023)	Controlled trial; n=240	Fitness diagnosis and prescription teaching	3	Improved fitness, cardiopulmonary, and mental-health outcomes
Alsaleh (2023)	Two-group RCT; n=150	Tailored consultation, texts, Facebook, monitoring	3	Increased activity and reduced BMI
Danielsen et al. (2023)	Feasibility pilot; n=13	Individually tailored group exercise	3	Supported feasibility for students with mental-health challenges
Zhang et al. (2024)	Randomized trial; n=28 analyzed	FMS-guided corrective training	3	Improved movement-pattern quality
Tao et al. (2024)	Retrospective pre–post; n=3,244	Fun Running, 15 weeks	0	Generated dose–response evidence for future prescriptions
Wang, Yuan, and Ji (2024)	Cluster RCT; n=78	Blended basketball PE	0	Improved several fitness components more than traditional learning
Cole et al. (2025)	Single-arm pilot; n=35	Walking and peer coaching	2	Improved walk/run performance but not most secondary outcomes
Huang et al. (2025)	Single-group intervention; n=26	Adaptation-informed sprint intervals	2	Improved fitness with high completion and moderate perceived exertion
Zhou et al. (2025)	Sensing-model study; n=92	Voice-based exercise-intensity classification	2	Supported noninvasive real-time intensity sensing
Sun et al. (2025)	Three-group randomized study; n=58	Online or hybrid HIIT	0	Hybrid delivery improved selected fitness and self-control outcomes
Zhang, Li, et al. (2025)	Three-arm RCT; n=83	App- or trainer-led exercise plus watches	1	Online and offline delivery had similar effects in men with overweight/obesity
Li, Meng, et al. (2025)	RCT; n=35 analyzed	Functional versus traditional training	0	Improved FMS and multiple fitness outcomes
Li, Su, et al. (2025)	Cluster controlled trial; n=123 analyzed	FMS-informed individual prescriptions	3	Improved FMS; quality-of-life effects were limited
Yang et al. (2026)	Two-arm RCT; n=160	Wearable/app monitoring plus gamification	2	Increased activity, adherence, and selected health outcomes

Note. FMS = Functional Movement Screen; FITT = frequency, intensity, time, and type; HIIT = high-intensity interval training; PE = physical education; RCT = randomized controlled trial.

3.2 Standardized exercise and subgroup targeting

The 15 level-0 studies showed that standardized programs can improve specific outcomes, but their effects should not be generalized across all dimensions of fitness or health. Baduanjin trials reported improvements in composite fitness, endurance, flexibility, proprioception, standing long jump, and attention, while several physiological and self-reported outcomes remained unchanged (Li et al., 2015; Ye et al., 2022). The Tai Chi trial similarly improved flexibility and balance but not most other outcomes (Zheng et al., 2015). These patterns support outcome–program matching: an intervention with plausible benefits for balance and flexibility should not automatically be described as a comprehensive solution for cardiovascular fitness, body composition, and mental health.

Curricular and functional-training studies broadened the menu of potentially effective options. Mandatory physical education was positively associated with longitudinal fitness-test scores, but the observational design did not establish that every student responded equally or that the reported model-based equivalence to weight change represented actual weight loss (Bao et al., 2020). Sport Education studies showed that skill practice and game play increased lesson activity and that motivation and physical literacy were plausible mechanisms for activity beyond the lesson (Choi et al., 2021, 2024). Blended basketball learning and fixed functional training improved several fitness outcomes compared with conventional instruction (Li, Meng, et al., 2025; Wang, Yuan, & Ji, 2024). These studies are valuable as a program library, yet they did not report participant-level matching rules.

Three level-1 studies selected an at-risk or underserved subgroup before delivering a common program. One Baduanjin trial focused on students exempted from standard fitness testing because of illness or disability (Wang, Zhang, & Wu, 2024). A basketball trial enrolled sedentary female students (Li et al., 2026), while an mHealth trial recruited male students with overweight or obesity (Zhang, Li, et al., 2025). Subgroup targeting improves relevance but can still conceal considerable heterogeneity. In the mHealth trial, watches captured physical activity and online delivery was comparable with trainer-led delivery, yet the prescribed program could not be switched or adjusted. Monitoring improved delivery and measurement without creating a response-adaptive prescription.

3.3 Assessment-informed and individual prescription studies

Six studies reached level 3. Zhao et al. (2023) assigned individualized aerobic or resistance prescriptions to students with depressive symptoms and monitored outcomes at multiple time points. Both forms improved symptoms and physical activity, but the article did not fully specify how participant-level parameters were generated or which response would trigger a change. Zhong et al. (2023) reported a teaching cycle that began with physical diagnosis and developed prescriptions for speed, strength, endurance, or functional improvement. The experimental group improved across several fitness, cardiopulmonary, and mental-health outcomes compared with conventional teaching. The approach was conceptually close to precision physical education, although the prescription algorithm and allocation procedures require clearer reporting for replication.

Functional movement assessment was used in two individualization pathways. Zhang et al. (2024) tailored corrective training to individual movement patterns and improved FMS scores, although physical-fitness improvements were not statistically significant in the small sample. Li, Su, et al. (2025) embedded individualized exercise prescriptions informed by screening within prescription-based health education. FMS improved, but quality-of-life effects were limited. These studies show why assessment must be connected to a target that the intervention can plausibly change: movement-quality screening may support pattern-specific corrective exercise, whereas claims about broader quality of life require additional behavioral and contextual mechanisms.

Two studies individualized support through counseling or exercise adaptation. Alsaleh (2023) combined individualized consultations with text reminders, a Facebook page, goal setting, self-monitoring, and feedback; physical activity increased and BMI declined over six months. Because several components changed simultaneously, the active ingredient could not be isolated. Danielsen et al. (2023) individually adjusted exercises and doses within a supervised group program for students facing mental-health challenges. Recruitment, retention, and absence of adverse events supported feasibility, while symptoms and fitness improved in a small uncontrolled sample. Together, these studies indicate that individualization can be delivered without a complex algorithm, but transparent reporting of decisions remains necessary.

3.4 Monitoring, feedback, and digital support

Level-2 studies demonstrated useful precision-support components without a complete individualized prescription. A smart step board combined a chest heart-rate sensor, mobile application, individual heart-rate-reserve zones, and colored real-time feedback (Kundakcı et al., 2023). The six-week home program improved cardiorespiratory and functional measures, but several gains were not maintained at follow-up, and the system did not report progression rules based on response. A voice-modeling study classified exercise intensity from acoustic features, illustrating a low-burden sensing option that could support future real-time monitoring (Zhou et al., 2025). It did not test whether using the prediction to adjust training improved safety, adherence, or fitness.

Coaching and gamification addressed adherence more directly. The brief Walking and Lifestyle Coaching program combined pedometers, self-monitoring, weekly reflection, and peer coaching; walk/run performance improved, but most psychological and body-composition outcomes did not (Cole et al., 2025). A larger randomized trial held the wearable/app platform and activity targets constant while adding team competition, progress bars, feedback, and incentives. Gamification produced substantial gains in steps, moderate-to-vigorous activity, adherence, and selected fitness and mental-health outcomes (Yang et al., 2026). The design isolated the incremental effect of gamification more effectively than most multicomponent studies, yet the weekly activity targets were still common across groups. Personalized prompts should therefore be distinguished from personalized exercise dosage.

Lower-level digital interventions offered both positive and cautionary findings. A fixed 10,000-step app intervention increased weekly steps and improved body weight, but its authors explicitly recommended future personalization of goals and feedback (Al-Nawaiseh et al., 2022). A wearable-plus-social-media pilot was feasible but underpowered and showed limited between-group effects (Pope et al., 2019). WeChat-based studies found that self-monitoring and social-norm information did not benefit all students equally and that self-monitoring alone was associated with reduced walking among some men (Xu et al., 2021). Digital contact can thus create data and engagement opportunities without guaranteeing a beneficial behavioral response.

3.5 Feedback quality, motivation, and implementation

Fitness assessment is often assumed to motivate exercise, but the feedback experiment by Chandler et al. (2021) challenges that assumption. Students receiving fitness-assessment feedback showed reductions in competence and intrinsic motivation compared with controls, and students who perceived their feedback negatively also reduced physical activity. The direction of the effect therefore depends on how feedback is interpreted, not merely whether it is individualized. A precision system that identifies deficits but provides no achievable pathway may be less supportive than a simpler system that frames progress, offers equivalent choices, and protects autonomy.

Contextual studies outside the core map reinforce this interpretation. Teacher support, autonomy support, self-efficacy, and physical literacy are associated with engagement and physical

activity in university physical education (Guo et al., 2025; Xia et al., 2025; Zhang & Yun, 2025). Conversely, mandatory use of sports applications can provoke psychological reactance, and policy endorsement may depend on identity congruence and perceived legitimacy (Guo, 2024; Zhang et al., 2025). These mechanisms explain why monitoring systems should disclose data use, avoid punitive ranking as the sole feedback mode, and preserve meaningful choice.

3.6 Absence of a reproducible adaptive closed loop

No study met all level-4 criteria. Several studies measured participants repeatedly, displayed real-time information, adjusted exercises to baseline findings, or described progression. None clearly reported the entire chain of decision variables, thresholds, actions, and safety overrides required to reproduce a response-adaptive system. For example, a study might record heart rate continuously but retain a fixed program, or prescribe exercise individually at baseline but omit criteria for increasing or reducing load. This was the clearest cross-study gap.

The evidence nonetheless supports six connected functions: multidimensional assessment, risk or need stratification, FITT prescription, process monitoring, interpretable feedback, and periodic adjustment. Teacher capability, student autonomy and self-efficacy, transparent data governance, efficiency, and equity operate across the whole pathway rather than as optional additions.

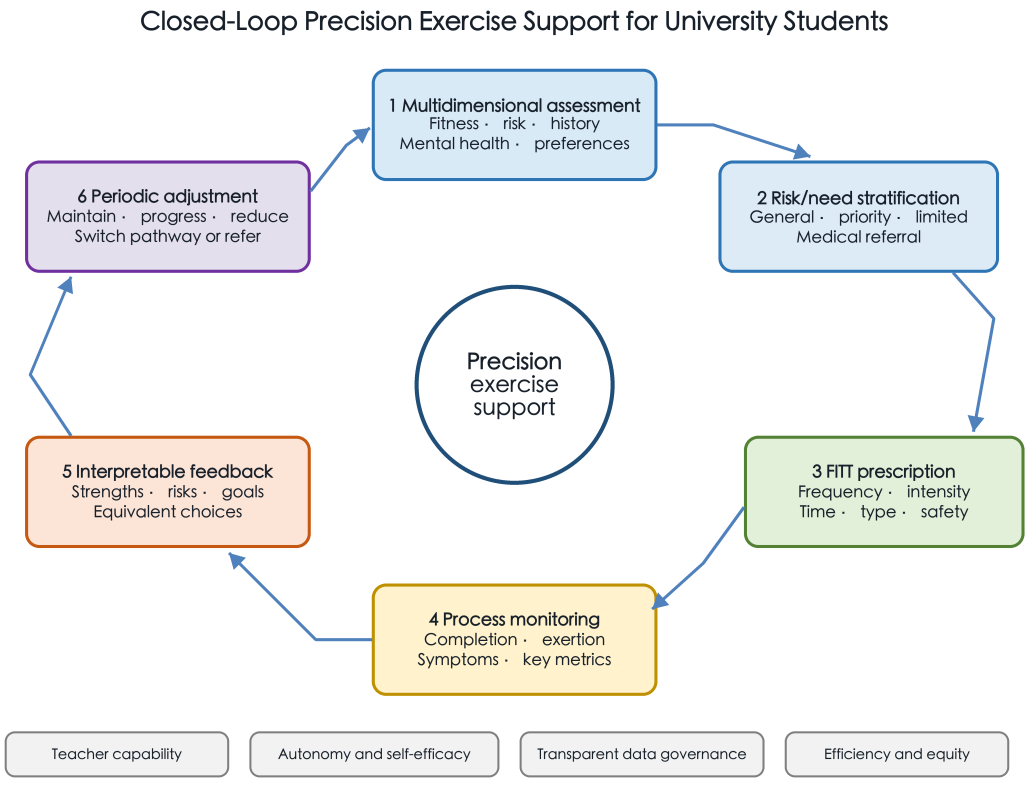


Figure 2. Closed-loop precision exercise support for university students. FITT = frequency, intensity, time, and type.

4. Discussion

4.1 Principal findings

Across the 30 included studies, precision-support functions were unevenly implemented. Standardized exercise accounted for half of the evidence map. Twelve studies used assessment adaptation or an individual prescription, yet none fully described a response-adaptive closed loop.

Exercise options and sensing methods have developed faster than the rules needed to connect measured information to training decisions.

Effectiveness and precision are separate properties. A standardized intervention can be effective, safe, and scalable; a personalized-looking interface can provide little meaningful adaptation. Claims should therefore remain component-specific. Existing evidence supports Baduanjin, Tai Chi, basketball, running, functional training, blended physical education, and mobile activity programs for selected outcomes and populations. Functional screening, individualized counseling, wearable monitoring, gamification, and real-time intensity feedback are promising decision or implementation components. Whether a complete adaptive system outperforms a well-designed standardized program remains unknown.

4.2 A minimum viable closed loop for universities

Universities do not need to begin with a complex artificial-intelligence platform. A minimum viable closed loop can use existing fitness testing and teacher-led decisions. At assessment, a small set of measures should represent the intended targets: cardiorespiratory fitness, strength or power, flexibility or movement quality, body composition where appropriate, health contraindications, previous exercise, symptoms, preference, and feasible participation time. Stratification should identify general promotion, priority improvement, exercise limitation, and medical referral rather than only pass/fail categories.

The prescription stage should specify FITT and a safety boundary. A class can retain common warm-up and skill instruction while using two or three differentiated main-task pathways. Monitoring can remain parsimonious: completion, session rating of perceived exertion, pain or adverse symptoms, and one or two target indicators. Feedback should state the student's current strength or risk, the next achievable goal, and available equivalent activities. Adjustment should occur at a prespecified interval, such as four to six weeks, using rules written before implementation. For example, adherence above 80%, target exertion within range, and absence of warning symptoms could trigger a modest load progression. Low adherence should first prompt a feasibility discussion rather than an automatic intensity increase. Pain, dizziness, or an abnormal physiological response should trigger load reduction or referral. The exact thresholds require validation, but publishing them would improve reproducibility.

4.3 Digital systems should support decisions, not merely collect data

Wearables and mobile platforms can capture activity at scale, return feedback quickly, and extend support beyond the classroom. Data volume, however, does not guarantee better decisions. Step count, heart rate, or activity minutes were often monitored continuously while the intervention target remained fixed. A precision-support platform should expose its decision logic so that students and teachers can see which data are used, how recommendations are produced, when they change, and what happens when information is missing or inconsistent.

The evidence on feedback also argues against purely deficit-based reporting. Chandler et al. (2021) found motivational harm when feedback was perceived negatively, and Xu et al. (2021) found that self-monitoring and social norms could produce sex-specific or counterproductive responses. Feedback should emphasize progress relative to a personal baseline, provide achievable next actions, and allow students to choose among equivalent forms of exercise. High-risk findings should be communicated privately with a referral route. These are not cosmetic design choices; they are part of intervention fidelity and safety.

4.4 Organizational efficiency as an implementation outcome

Precision support must work at university scale. Operational outcomes were rarely measured in the included studies, even though staffing and throughput may determine adoption. Automated fitness-testing equipment can plausibly reduce the number of separate roles required for starting,

timing, and recording a 50-m sprint and can allow several students to be processed concurrently. That is an organizational-efficiency hypothesis, not evidence of measurement accuracy or improved student fitness.

An appropriate evaluation would use a prospective time–motion comparison between the instrument-assisted and conventional workflows. Outcomes could include students completed per teacher-hour, total staff positions, mean test time, waiting time, proportion of records requiring manual correction, missing or mismatched results, equipment downtime, and cost per completed student. Repeated observations across busy and nonbusy periods would allow uncertainty to be estimated. Claims about accuracy would require a separate agreement or validity study against an accepted reference method. This distinction makes it possible to publish meaningful implementation evidence even when a long-term exercise-outcome trial is not feasible.

4.5 Research agenda

The most informative next trial would compare standardized, baseline-adapted, and response-adaptive versions of the same exercise program. Holding the exercise mode constant would isolate the incremental value of precision. Stratified or pragmatic randomization could ensure representation of low fitness, exercise limitation, obesity, and mental-health needs. Reports should provide the variables used for matching, the initial prescription, progression and regression thresholds, adherence, actual delivered dose, adverse events, missing-data handling, and deviations from the algorithm.

Outcome reporting should move beyond mean change. The proportion of students reaching a meaningful improvement, response heterogeneity by baseline status, and the distribution of adverse or nonresponse outcomes are directly relevant to precision. Studies should also report reach, acceptability, teacher workload, equity, data completeness, system failures, and cost. Where algorithms are used, external validation and human override procedures should be described. A digital system should not silently intensify training when sensor data are implausible or when a student reports symptoms.

4.6 Strengths and limitations

This review combined three English-language databases, an existing full-text seed set, record-level screening audits, full-text PDF conversion, and an explicit decision-level taxonomy. The resulting 30-study evidence map distinguishes standardized effectiveness, subgroup targeting, assessment adaptation, individual prescription, and true response adaptation. It also integrates motivational and organizational considerations that are often separated from exercise efficacy.

Several limitations remain. The supplementary search was limited to English, and the database strategies were intentionally broad but may not capture every study whose title and abstract omitted precision-related terminology. Screening was conducted by one reviewer; although uncertain records were retained conservatively and all decisions were logged, independent duplicate screening would reduce selection error. The 28-report seed set was not itself generated by the same prospective database protocol. No formal risk-of-bias assessment was conducted, consistent with the mapping purpose of many scoping reviews, but this limits judgments about comparative effectiveness. Some included studies used small samples, single sites, short interventions, multiple unblinded components, self-reported outcomes, or incomplete descriptions of randomization and prescription generation. Finally, the five-level framework is an analytic proposal and should be tested for inter-rater reliability and usefulness in future reviews.

5. Conclusions

Exercise and physical-education research with university students has begun to incorporate subgroup targeting, functional assessment, individualized prescription, wearable monitoring,

coaching, real-time feedback, and gamification. These components support a transition beyond uniform provision, but no included study fully reported a reproducible response-adaptive closed loop. Digital monitoring should therefore not be treated as synonymous with precision. The next step is to make the decision pathway explicit: assess, stratify, prescribe, monitor, explain, and adjust using transparent rules. Universities should evaluate not only fitness and mental-health outcomes but also adherence, safety, autonomy, equity, teacher workload, testing throughput, data quality, and cost.

Declarations

Funding. This research received no external funding.

Conflicts of interest. The authors declare no conflicts of interest.

Ethics approval. Not applicable; this study synthesized published literature.

Data availability. The search log, screening audit, evidence map, and source-document inventory are retained in the project archive and can be made available with the submitted manuscript, subject to publisher copyright restrictions on full-text PDFs.

References

Al-Nawaiseh, H. K., McIntosh, W. A., & McKyer, L. J. (2022). An mHealth intervention using a smartphone app to improve physical activity in college students: A randomized controlled trial. *International Journal of Environmental Research and Public Health, 19*(12), 7228. https://doi.org/10.3390/ijerph19127228

Alsaleh, E. (2023). Is a combination of individual consultations, text message reminders and interaction with a Facebook page more effective than educational sessions for encouraging university students to increase their physical activity levels? *Frontiers in Public Health, 11*, 1098953. https://doi.org/10.3389/fpubh.2023.1098953

Bao, D., Xiao, Z., Zhang, Y., Chen, G., Miao, X., Wang, B., Li, J., Xu, C., & Teng, S. (2020). Mandatory physical education classes of two hours per week can be comparable to losing more than five kilograms for Chinese college students. *International Journal of Environmental Research and Public Health, 17*(24), 9182. https://doi.org/10.3390/ijerph17249182

Brazo-Sayavera, J., Silva, D. R., Lang, J. J., Tomkinson, G. R., Agostinis-Sobrinho, C., Andersen, L. B., García-Hermoso, A., Gaya, A. R., Jurak, G., Lee, E.-Y., Liu, Y., Lubans, D. R., Okely, A. D., Ortega, F. B., Ruiz, J. R., Tremblay, M. S., & Dos Santos, L. (2024). Physical fitness surveillance and monitoring systems inventory for children and adolescents: A scoping review with a global perspective. *Sports Medicine, 54*(7), 1755–1769. https://doi.org/10.1007/s40279-024-02038-9

Chandler, L., Lee, J. W., Lesniak, K. T., & Herring, R. P. (2021). Fitness assessment feedback may lower intrinsic motivation for physical activity among college students. *California Journal of Health Promotion, 19*(1), 54–63.

Choi, S. M., Sum, K. W. R., Leung, F. L. E., Ha, S. C. A., Sit, C., & Yeung, K. H. (2021). Predictors of physical activity levels in university physical education implementing sport education. *Journal of Sports Science and Medicine, 20*(3), 516–524. https://doi.org/10.52082/jssm.2021.516

Choi, S. M., Sum, K. W. R., Wallhead, T. L., Leung, F. L. E., Ha, S. C. A., & Sit, H. P. C. (2022). Operationalizing physical literacy through sport education in a university physical education program. *Physical Education and Sport Pedagogy, 27*(6), 591–607. https://doi.org/10.1080/17408989.2021.1915266

Choi, S. M., Wang, F.-J., Sum, R. K. W., Ching, B. H.-H., Leung, E. F. L., & Ho, R. W. K. (2024). The motivational impact of sport education model on daily physical activity levels among university students: A mediation analysis. *Scientific Reports, 14*(1), 27964. https://doi.org/10.1038/s41598-024-78446-8

Cole, A., Corrales, F., Stone, E., & Biber, D. (2025). The Walking and Lifestyle Coaching (WALC) program for university students: A pilot study. *American Journal of Lifestyle Medicine, 19*(6), 888–898. https://doi.org/10.1177/15598276241266783

Danielsen, K. K., Cabral, D., & Sveaas, S. H. (2023). "Students Moving Together," tailored exercise for students facing mental health challenges—A pilot feasibility study. *International Journal of Environmental Research and Public Health, 20*(17), 6639. https://doi.org/10.3390/ijerph20176639

Dong, X., Huang, C., Starratt, G., & Yang, Y. (2023). Trend in health-related physical fitness for Chinese male first-year college students: 2013–2019. *Frontiers in Public Health, 11*, 984511. https://doi.org/10.3389/fpubh.2023.984511

Guo, J. (2024). Exploring college students' resistance to mandatory use of sports apps: A psychological reactance theory perspective. *Frontiers in Psychology, 15*, 1366164. https://doi.org/10.3389/fpsyg.2024.1366164

Guo, Q., Wang, X., Gao, Z., Gao, J., Lin, X., & Samsudin, S. (2025). The influence of teacher support on student engagement in physical education among college students: The mediating effects of autonomous motivation and self-efficacy. *PLOS ONE, 20*(9), e0331876. https://doi.org/10.1371/journal.pone.0331876

Huang, G., Chen, Y., Lee, B., Qiu, Y., Mao, A., Liang, M., & Liu, M. (2025). A study on the effects of modified sprint interval training on physical fitness test scores and the quantitative and dose-response relationships among Chinese male university students. *Frontiers in Physiology, 16*, 1555019. https://doi.org/10.3389/fphys.2025.1555019

Kundakcı, Y. E., Taşkın, G., Taşvuran Horata, E., & Koz, M. (2023). Home-based bench step exercise program with Smart Step Board: A comparative pilot study. *Turkish Journal of Sports Medicine, 58*(2), 74–81. https://doi.org/10.47447/tjsm.0727

Li, B., Su, Y., Zhu, L., & Yang, J. (2025). Prescription-based health education integrating functional movement screening: A controlled trial in Chinese university students. *Frontiers in Public Health, 13*, 1649030. https://doi.org/10.3389/fpubh.2025.1649030

Li, L., Meng, F., Yao, S., Shi, Q., & Luo, C. (2025). The effects of an 8-week functional training program on functional movement and physical fitness in male university students: A randomized controlled trial. *Frontiers in Public Health, 13*, 1641590. https://doi.org/10.3389/fpubh.2025.1641590

Li, L., Han, X., Chen, J., Wen, Q., De Conti Teixeira Costa, G., Trybulski, R., & Clemente, F. M. (2026). Comparative effects of 1v1 versus 3v3 small-sided basketball training on body anthropometric-related outcomes and physical fitness in sedentary female college students: An 8-week randomized controlled trial. *Journal of Sports Science & Medicine, 25*(2), 514–528. https://doi.org/10.52082/jssm.2026.514

Li, M., Fang, Q., Li, J., Zheng, X., Tao, J., Yan, X., Lin, Q., Lan, X., Chen, B., Zheng, G., & Chen, L. (2015). The effect of Chinese traditional exercise-Baduanjin on physical and psychological well-being of college students: A randomized controlled trial. *PLOS ONE, 10*(7), e0130544. https://doi.org/10.1371/journal.pone.0130544

Lin, J., Gao, Y., Zhang, Q., & Zheng, L. (2022). Effects of qigong exercise on the physical and mental health of college students: A systematic review and meta-analysis. *BMC Complementary Medicine and Therapies, 22*(1), 287. https://doi.org/10.1186/s12906-022-03760-5

Pan, M., Ying, B., Lai, Y., Wang, T., & Luo, J. (2022). Status and influencing factors of physical exercise among college students in China: A systematic review. *International Journal of Environmental Research and Public Health, 19*(19), 12263. https://doi.org/10.3390/ijerph191912263

Peters, M. D. J., Godfrey, C., McInerney, P., Munn, Z., Tricco, A. C., & Khalil, H. (2024). Scoping reviews. In E. Aromataris, C. Lockwood, K. Porritt, B. Pilla, & Z. Jordan (Eds.), *JBI manual for evidence synthesis*. JBI. https://doi.org/10.46658/JBIMES-24-09

Pope, Z. C., Barr-Anderson, D. J., Lewis, B. A., Pereira, M. A., & Gao, Z. (2019). Use of wearable technology and social media to improve physical activity and dietary behaviors among

college students: A 12-week randomized pilot study. *International Journal of Environmental Research and Public Health, 16*(19), 3579. https://doi.org/10.3390/ijerph16193579

Qi, F., Soh, K. G., Mohd Nasirudddin, N. J., & Mai, Y. (2022). Effects of Tai Chi on physical and psychological health of college students: A systematic review. *Frontiers in Physiology, 13*, 1008604. https://doi.org/10.3389/fphys.2022.1008604

Sun, J., Liang, H., Wang, L., Chen, Z., Bi, C., & Zhang, F. (2025). Secular trends of physical fitness for college students in Anhui province over the past decade. *BMC Public Health, 25*(1), 357. https://doi.org/10.1186/s12889-025-21613-x

Sun, Y., Wang, Y., Yu, H., Cheng, K., Wang, H., & Liu, J. (2025). To explore the effects of different ways of high intensity interval training on self-control and physical health of college students. *Frontiers in Public Health, 13*, 1550598. https://doi.org/10.3389/fpubh.2025.1550598

Tao, Z., Sun, X., Sun, J., & Zhu, E. (2024). Dose-response relationship between 15 weeks of running and aerobic fitness: A retrospective analysis based on the Fun Running program. *BMC Public Health, 24*(1), 1019. https://doi.org/10.1186/s12889-024-18484-z

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., . . . Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine, 169*(7), 467–473. https://doi.org/10.7326/M18-0850

Wang, C., Yuan, Y., & Ji, X. (2024). The effects of a blended learning model on the physical fitness of Chinese university students: A cluster randomized controlled trial in basketball education. *BMC Public Health, 24*(1), 2451. https://doi.org/10.1186/s12889-024-20001-1

Wang, F., & Ali, S. K. S. (2023). Exploring the attitude of college students towards Tai Chi: A quasi experiment of a short Tai Chi course. *Journal of Namibian Studies: History Politics Culture, 33*, 5912–5929. https://doi.org/10.59670/jns.v33i.4435

Wang, Z., Zhang, Z., & Wu, Y. (2024). The effects of Baduanjin exercise on the psychological condition and heart rate variability of sports-disadvantaged college students: A randomised trial. *Journal of Health, Population and Nutrition, 43*(1), 203. https://doi.org/10.1186/s41043-024-00691-4

Xia, Q., Xuan, S., Zhang, T., & Zong, B. (2025). How autonomy support sustains emotional engagement in college physical education: A longitudinal study. *Behavioral Sciences, 15*(6), 822. https://doi.org/10.3390/bs15060822

Xu, Y., Yue, L. Z., Wang, W., Wu, X. J., & Liang, Z. Y. (2021). Gender-specific impact of self-monitoring and social norm information on walking behavior among Chinese college students assessed using WeChat: Longitudinal tracking study. *Journal of Medical Internet Research, 23*(12), e29167. https://doi.org/10.2196/29167

Yang, M., Guo, Y., Li, Z., Jiang, L., Gao, Y., Yang, S., & Zhou, Z. (2026). A gamified mobile health intervention to promote physical activity, executive function, and mental health in college students: Randomized controlled trial. *Journal of Medical Internet Research, 28*, e82769. https://doi.org/10.2196/82769

Yang, T., Guo, Y., Cheng, Y., & Zhang, Y. (2022). Effects of traditional Chinese fitness exercises on negative emotions and sleep disorders in college students: A systematic review and meta-analysis. *Frontiers in Psychology, 13*, 908041. https://doi.org/10.3389/fpsyg.2022.908041

Ye, Y., Zhao, F., Sun, S., Xiong, J., & Zheng, G. (2022). The effect of Baduanjin exercise on health-related physical fitness of college students: A randomized controlled trial. *Frontiers in Public Health, 10*, 965544. https://doi.org/10.3389/fpubh.2022.965544

Yin, S., Tang, F., & Gao, P. (2025). Development and validation of the physical fitness test anxiety scale for college students. *Frontiers in Psychology, 16*, 1573530. https://doi.org/10.3389/fpsyg.2025.1573530

Zhang, Q., Li, Z., Jiang, L., Gao, Y., Gong, T., Li, J., & Zhou, Z. (2025). Effects of an exercise intervention based on mHealth technology on the physical health of male university students with overweight and obesity: Randomized controlled trial. *Journal of Medical Internet Research, 27*, e69451. https://doi.org/10.2196/69451

Zhang, X., & Yun, J. (2025). The relationship between high-quality physical education, physical literacy, and physical activity participation: A retrospective study from U.S. college students. *Research Quarterly for Exercise and Sport, 96*(4), 627–636. https://doi.org/10.1080/02701367.2025.2472943

Zhang, Y., Dong, F., Duan, C., & Shi, Y. (2025). Identity-congruence policy endorsement: A study of cognitive mediation in app-based fitness compliance intentions among Chinese college students. *Acta Psychologica, 260*, 105628. https://doi.org/10.1016/j.actpsy.2025.105628

Zhang, Z., Chen, L., Qin, Z., He, J., Gao, C., Sun, J., Chen, J., & Li, D. (2024). Effects of functional correction training on movement patterns and physical fitness in male college students. *PeerJ, 12*, e16878. https://doi.org/10.7717/peerj.16878

Zhao, Y., Wang, W., Wang, M., Gao, F., Hu, C., Cui, B., Yu, W., & Ren, H. (2023). Personalized individual-based exercise prescriptions are effective in treating depressive symptoms of college students during the COVID-19: A randomized controlled trial in China. *Frontiers in Psychiatry, 13*, 1015725. https://doi.org/10.3389/fpsyt.2022.1015725

Zheng, G., Lan, X., Li, M., Ling, K., Lin, H., Chen, L., Tao, J., Li, J., Zheng, X., Chen, B., & Fang, Q. (2015). Effectiveness of Tai Chi on physical and psychological health of college students: Results of a randomized controlled trial. *PLOS ONE, 10*(7), e0132605. https://doi.org/10.1371/journal.pone.0132605

Zhong, X. L., Sheng, D. L., Cheng, T. Z., & Zhang, Z. W. (2023). Effect of exercise prescription teaching on exercise quality and mental health status of college students. *World Journal of Psychiatry, 13*(5), 191–202. https://doi.org/10.5498/wjp.v13.i5.191

Zhong, Y., Guo, W., Xue, Y., Chen, P., & Wang, Y. (2025). The effect of digital media on college students' sports participation: The mediating role of sports cognition and the moderating role of self-efficacy. *PLOS ONE, 20*(9), e0330445. https://doi.org/10.1371/journal.pone.0330445

Zhou, S., Ma, R., Hu, W., Zhang, D., Hu, R., Zou, S., Cai, D., Jiang, Z., Ding, H., & Liu, T. (2025). Voice as a sensitive biomarker for predicting exercise intensity: A modelling study. *Frontiers in Physiology, 16*, 1483828. https://doi.org/10.3389/fphys.2025.1483828

Appendix A. Database search summary

Table A1

Database yields and principal search concepts

	Source	Search structure	Filters	Records
Q1	PubMed	Student terms AND personalized/individualized/tailored exercise or exercise prescription	2010–2026; title/abstract concepts	45
Q2	PubMed	Student terms AND exercise/fitness/PE AND wearable/app/monitoring/feedback AND intervention/trial/program	2010–2026; title/abstract concepts	99
Q3	PubMed	Student terms AND physical fitness AND exercise/training program or randomized trial	2010–2026; title/abstract concepts	88
Q4	PubMed	Student terms AND PE/fitness course AND differentiated/individualized/adaptive instruction	2010–2026; title/abstract concepts	2
	Scopus	Student terms AND personalized/individualized/tailored/prescribed/monitored/feedback/adaptive exercise or PE	English	133
Ultimate	CINAHL	Student terms AND physical fitness/exercise/PE AND personalized/stratified/prescribed/wearable/monitoring/feedback	English; peer reviewed; research article; 2016–2026	8

Note. The four PubMed searches yielded 234 records before within-database deduplication and 230 unique records. Exact search strings and exported records are retained in the search audit folder.