

Wearable Feedback and Self-Regulated Physical Activity in School Physical Education: A Narrative Review of Motivation, Assessment and Long-Term Behaviour Change

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ABSTRACT:

Fitness bracelets have ceased being a consumer device and are now being introduced in school educational physical education and ASCA as a motivational, self-monitoring, and evaluation device. Nevertheless, the educational impact of these devices has been debated since the greater the number of steps, the less likely it is to reflect greater learning, equal participation, or long-term behaviour change. This narrative review critically analysed new evidence on wearable feedback in school and adolescent physical activity contexts, focusing on self-regulated learning, motivation, assessment design, and long-term behaviour maintenance. A thematic synthesis was conducted on primary studies and high-quality reviews published in the last 5 years (between 2021 and 2026). The review discovered wearables to be most pedagogical when part of teacher-lead goal setting, reflective feedback, autonomy-supportive instruction, and formative assessment. Conversely, interventions that conceptualised devices as prompting devices generated less powerful or adverse outcomes, especially where there was degradation of engagement or feedback was not translated into practical learning activities. Tensions persisted around privacy, data accuracy, teacher readiness, and student comparison and maintenance after interventions. This paper claims that wearable trackers cannot be comprehended as mechanisms of impartial measurement but as a feedback mechanism on pedagogy which can have effects determined by the alignment of curriculum, ethical design, and ongoing mediation of instruction.

Keywords: wearable technology; school physical education; activity trackers; self-regulation; motivation; feedback; adolescents; assessment AI-driven marketing; digital real estate; Bangalore; residential housing; market dynamics.

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Introduction

School PE is supposed to produce physically active, health-literate, and self-controlling children, but a majority of adolescent children do not engage in adequate daily physical

activities, despite being subjected to recurrent curriculum--based health messages. Wearable activity trackers have thus gained interest as they provide instant, individualised, and seemingly objective information regarding the number of

steps, intensity, heart rate, and goal attainment. Emerging data indicate that wearable devices have the potential to boost the number of daily steps in children and adolescents but not moderate-to-vigorous physical activity (MVPA), sedentary behaviour, and sustained use (Au et al., 2024; Casado-Robles et al., 2022; Chen et al., 2025). This difference is critical to PE because the knowledge of a school should not be diminished by the accumulation of motion in numbers. Even though a student might take more steps in the meantime, they do not comprehend pacing, health-related fitness, autonomy, or long-term behaviour planning.

The pedagogical potential of wearables is based on the ability to relate physical activity to feedback, goal setting, self-monitoring, and reflections. This promise has taken on greater topicality, with PE teachers being requested to demonstrate learning outcomes to reinforce health promotion, inclusion, and student agency. These aspects are associated with self-regulated learning as learners can measure actual behaviour against targets, evaluate progress, and strategise future actions. Nonetheless, a tracker may also restrict learning when teachers employ it simply to rank or reward compliance. It has been observed in reviews that self-monitoring, competition, and social comparison might potentially boost motivation, although novelty effects, technical burden, and unequal access emerge as threats to long-term value (Creaser et al., 2021; Zhao & Su, 2026). Publicity, inaccuracy, anarchism of data, or lack of connection to personal context can lead to the same feedback that encourages one learner to discourage another.

This tension is evident in recent trials involving PE. Other school studies with activity wristbands in organised teaching units exhibited positive changes in autonomy support, psychological needs, autonomous motivation, and weekly steps (Guijarro-Romero et al., 2023, 2024). In contrast, the RAW-PA trial in underprivileged schools did not positively influence MVPA and had reduced MVPA at six months in the intervention group, which means that Fitbit feedback/app challenges were not

sufficiently applied to enhance MVPA (Ridgers et al., 2021; Verswijveren et al., 2022). Research on the use of step-tracker apps as PE assignments also demonstrated that positive results may fade as soon as the forced and encouraged usage is over (Mateo-Orcajada et al., 2024). These results change the focus of the research question to how wearables can work, not whether they do so, and to whom and in what pedagogical circumstances wearables can be used to support durable learning.

This review is necessary because most wearable studies still focus on the concepts of health promotion and device effectiveness, but less work has investigated wearables as a feedback system as part of PE assessment and self-regulated learning. Critical narrative synthesis can combine experimental, quasi-experimental, and qualitative data to determine transferable design principles. Thus, the purpose of this narrative review was to consider how wearable trackers can facilitate motivation, self-managed learning, evaluation, and lifelong body exercise among school students.

Methods

A narrative review design was chosen because the evidence on wearable feedback in school PE was heterogeneous in the design of interventions, type of device, age group, purpose, and outcome measurement of education. A standard systematic review or meta-analysis would not have been an ideal fit for the current objective since the effectiveness of the interventions was not the sole objective, but also pedagogical meaning, assessment logic, and behavioural maintenance. The review thus utilised a structured narrative process, providing an opportunity to compare the trials, quasi-experimental studies, cross-sectional studies, qualitative teacher research, and current reviews.

Searches were performed between June 2026, PubMed, Google Scholar, Scopus pages indexed by Hebibase, JMIR, MDPI, Taylor and Franklin, Springer, Frontiers, and pertinent PE education databases. The search strings used were wearable and learning words, such as wearable technology AND school physical education,

activity trackers AND adolescents, fitness tracker application AND physical education, wearable feedback/assessment AND motivation, self-regulation/physical activity, and assessment AND physical activity. The search was anchored using the three sources of seeds provided to the project to find backward and forward citations.

The inclusion criteria were as follows: the study should be published between 2021 and 2026, involve children or adolescents, utilise wearable trackers, wristbands, smart bands, step-tracker apps, or sensor-based feedback, and report outcomes that rely on PE, school activity, motivation, self-monitoring, assessment, or behaviour change. The latest research findings of 2020 were not employed as fundamental sources because the manuscript was designed to capture a recent five-year publication range and the fast-growing post-pandemic digital feedback research in schools. Priority was given to primary studies in the thematic results because the review aimed to construct claims based on empirical data rather than reiterate the findings of existing reviews. Only systematic reviews and meta-analyses that shed light on the evidence base, direction of effects, or understanding of the conceptual gap were retained. Only studies with adult populations, clinical rehabilitation, elite sports, and engineering prototypes with no

educational use or general digital health with no wearable feedback were excluded.

The author, year, setting, participants, device, intervention logic, outcome focus, and key pedagogical implications were charted as evidence. The use of wearables as a measuring tool, motivational aid, feedback aid, assessment aid, or broader behaviour-change scaffold was also investigated in each main study. This difference was significant since two studies may work with one and the same device but can have quite different educational goals. Three rounds of thematic synthesis were done. First, this involved reading studies on the role of the device in the paper, such as monitoring, prompting, feedback, gamification, or assessment. Second, the findings were coded into four sensitising concepts: motivation, self-regulated learning, assessment, and long-term behaviour maintenance. Third, convergent and contrasting findings were used to determine the conditions under which wearable feedback was pedagogically productive or constrained. This method was reasonable because more recent evidence does not confirm a mere positive or negative opinion on wearables. Rather, those in the literature indicate that the results were different depending on the teacher mediation, the goal structure, student engagement, device validity, post-intervention continuity, and data privacy.

Table 1. Review search design and methodological justification

Component	Decision used in this review	Justification
Review type	Structured narrative review	A narrative design was suitable because the evidence varied across trials, school interventions, app-based assignments, qualitative teacher studies, and reviews.
Search period	Literature from 2021 to 2026	The topic is rapidly changing because devices, apps, and PE digital practices have developed quickly after the pandemic.
Search terms	Wearable technology, school physical education, activity trackers, self-regulation, motivation, feedback, adolescents and assessment	These terms captured both device- and pedagogy-centred evidence.

Evidence priority	Primary studies were used for thematic findings	An empirical comparison of how wearable feedback works in real school or adolescent contexts is required.
Synthesis logic	Thematic comparison across motivation, self-regulation, assessment and maintenance	This allowed the review to compare positive and negative findings, rather than report only the overall effectiveness.

Table 2. Thematic findings from selected primary studies

Study	Context and wearable role	Main finding	Critical interpretation
Guijarro-Romero et al. (2023, 2024)	Secondary PE teaching units with activity wristbands, goals and counselling	Improved motivation, psychological needs and weekly steps	Wearables worked best when the data were interpreted through teacher-guided autonomy support.
Ridgers et al. (2021) and Verswijveren et al. (2022)	Fitbit, app, online challenges and resources in disadvantaged schools	No MVPA improvement and limited mediator change	Device access and digital challenges were insufficient without sustained engagement and contextual fitting.
Mateo-Orcajada et al. (2023, 2024)	Step-tracker apps used as mandatory PE-related assignments	Initial benefits faded when use stopped being mandatory	Compliance does not automatically become a long-term self-regulated behaviour.
Carson et al. (2025)	Fitbit-supported, tailored digital intervention for underactive Latina adolescents	Improved MVPA and steps at follow-up	Culturally tailored feedback and support may improve equity and relevance of the intervention.
Lin et al. (2021)	Wearable feedback for badminton skill learning	Enhanced skill-related feedback and movement learning	Wearables can support PE assessment beyond steps when linked to movement.
Creaser et al. (2022) and Almusawi et al. (2021)	School staff and PE teacher perspectives	Teachers saw value but raised readiness and implementation issues	Pedagogical competence and school infrastructure shaped the usefulness of feedback.

Thematic findings

Conceptualising wearable feedback as pedagogy

As a recent development, the focus of wearables has shifted away from wearables as counting tools to wearables as learning interfaces. Consumer trackers provide step counts, heart rate feedback, alerts, badges, and app dashboards. These characteristics in health promotion studies are commonly considered behaviour change methods. In PE, however, curricular interpretation is required for the same features. Short helping learners realise why the target is important, how it can be modified, and the manner in which the progress of the target ought to be measured is the only educational step target. The use of wearable technologies helped in providing real-time feedback, self-monitoring, gamification, and goal setting in school PE, although Zhao and Su (2026) also indicated that it relied on teacher digital competence and ethical data management. This indicates that the machine was not a stand-alone machine. The instructional decisions made were pedagogically useful.

This interpretation is supported by primary studies. Guijarro-Romero et al. (2023) incorporated the concept of activity wristbands into an intermittent unit of PE teaching that incorporated counselling, prompts and individualised objectives. All of the interventions led to better autonomy support, need satisfaction, and autonomous motivation, which indicates that wearable information can assist with self-determined participation as long as the feedback is applied to support the choice and reflection. Guijarro-Romero et al. (2024) provided better results on the number of steps in a week and the percentage of students who meet the requirements of steps, which proves that positive psychological and behavioural results become possible if pedagogy converts data into practice. In contrast, Ridgers et al. (2021) provided Fitbit devices, an app, and challenges in disadvantaged schools but did not increase MVPA. Verswijveren et al. (2022) found the hypothesised mediators with limited

effects and low engagement with weekly challenges. These conflicting results suggest that the volume of feedback is less significant than feedback uptake. PE pedagogy needs to transform information into self-regulated learning, a role played by wearables.

Motivation, autonomy and social comparison

Wearables have the potential to inspire the younger generation, ensuring that this effort is visible, in the moment, and can be tracked personally. Research on PE-based trackers and fitness applications has demonstrated that students are more actively engaged in activities when they can view their progress and relate the activity to their individual goals (Liu et al., 2021; Rusmitaningsih et al., 2024). The Chicas Fuertes intervention trial integrated wearable data with individualised reports, texts, and online content, and MVPA/step interventions resulted in positive improvements in underactive Latino adolescents after six months (Carson et al., 2025). This result is important because it demonstrates that culturally and socially oriented feedback could help groups, as not always addressed by generic PE interventions.

However, the motivation was not successful. Creaser et al. (2021) revealed inconsistent effectiveness evidence and reported novelty effects, pain, and technical challenges. The attraction of the wearable might be initially caused by the fact that it is new, but the level of attraction might decrease when the data become common or overwhelming. There is also a two-fold effect of social comparison. Participation may be provoked by competition and leaderboards in some students, but demotivates less fit and less confident learners, the disabled, or those who have body image issues or fewer opportunities to be active out of school. The RAW-PA results are significant in this aspect because a multi-component intervention involving challenges based on apps did not positively affect MVPA and even reduced MVPA at six months in the intervention group (Ridgers et al., 2021). This does not imply that competition is always detrimental. Instead, it

proposes that motivation design must be autonomy-supporting, private where needed, and mindful of various starting points.

The stronger pieces of evidence then incline towards personalised mastery feedback as opposed to mere ranking. Motivation in PE should be viewed as a learning process rather than an emotional response to a device. Students should set, update, and justify goals and decisions regarding the types of activities. Wearable feedback to support these processes is consistent with self regulation. It becomes dangerous when it only highlights disparities among students because it may reproduce inequity.

Self-regulated learning and behaviour maintenance

Self-regulated physical activity involves monitoring behaviour, interpolating feedback, planning change, and assessment with respect to time. Wearables seem to be highly compatible with the monitoring aspect because they can document activity with minimal burden and offer visual cues for improvement. However, the literature demonstrates that monitoring alone is insufficient. Mateo-Orcajada et al. (2023) discovered that obligatory post-school use of step-tracker apps enhanced activity, body composition, and fitness variables among teenagers. However, a follow-up trial reported that the benefits vanished when the use of pedometers ceased being mandatory and encouraged, and the intervention failed to establish a habitual walking routine (Mateo-Orcajada et al., 2024). This is among the most significant discoveries in PE, as it demonstrates the contrast between compliance and internalised self-regulation.

The evidence on gamified and intermittent teaching units is more positive, yet conditional. Becerra-Fernández et al. (2025) achieved psychological mediator improvement and objective weekly activity in PE through wearable-based gamification. This implies that the richer the narrative of a game, the better the self-regulation environment established by its goals and feedback. However, gamification may

also be overambitious, relying on external rewards in the absence of reflection. The most justifiable pedagogical stance then lies not in gamification motivating, nor in gamification being able to scaffold self-regulation where students must interpret information, modify strategies, and align short-term objectives with personally relevant purposes of doing so.

The weakest area of evidence is the long-term behaviour change. Another thing in Reviews and trials have demonstrated a greater effect of daily steps compared to either MVPA or sustained behaviour (Au et al., 2024; Casado-Robles et al., 2022; Chen et al., 2025). The steps are simple to comprehend, yet not all learning outcomes of PE, including movement competence, tactical understanding, enjoyment, social participation, or health literacy, are included. Consequently, wearable feedback must be placed as a part of long-term behaviour education, instead of evidence that a student has been taught to be active. The teacher's task is to assist students in transferring short-term feedback into long-term routines.

Assessment, validity and teacher mediation

The most intuitive part of wearables, in this case, lies in assessment. Trackers can be useful in providing formative assessment, giving students and teachers repeated data points instead of using occasional observation or self-report. In reference to Creaser et al. (2022), staff members at the schools asserted the usefulness of wearables related to monitoring of activity, supporting PE lessons, motivating movement breaks, and providing proof to discuss. This is in line with assessment of learning, since data can be utilised to inform feedback and further aspirations. Similarly, Lin et al. (2021) provided badminton teaching through wearable feedback, comparing the patterns of movement and strength performance of learners with expert models, which demonstrated that sensor data can go beyond steps to skill learning.

Conversely, it cannot be assumed that the data are valid. Sousa et al. (2023) mentioned that wearable technologies are becoming more available for measuring physical activity among

young people, although the validation process differs according to the devices, activities, and locations. As Mayorga-Vega et al. (2023) also stressed, the estimates of wristbands in schoolchildren need to be interpreted cautiously in free-living conditions. Assessment equity is destroyed when teachers employ erroneous approximations as summative scores. This is especially problematic for students whose activity cannot be effectively measured using step-based instruments, such as cycling, swimming, resistance exercise, and wheelchair sports or movements that require upper body work.

Thus, teacher mediation is a key focus. Almusawi et al. (2021) demonstrated that PE teachers identified access to and capability and belief regarding technology as readiness to prevent injury, good exercise and decreased sedentary behaviour. A tracker can help in professional judgement but cannot substitute it. An improved assessment practice would utilise wearable data to support itself, meaning to triangulate with student reflection and teacher observation, and would not directly grade students based on the raw steps. The available data indicate a cautious model of data-informed PE rather than a data-driven PE. Numbers in PE are a source of conversation for data-informed PE. In data-driven PE, data are the curriculum.

Equity, privacy and implementation constraints

Ethical and equity challenges are also brought up through wearable feedback which is often addressed as technical but is actually more of a pedagogical issue. Students vary in their ability to use smartphones, access to charging facilities, access to the Internet, space (privacy) to engage in activities, and family assistance. Assessment of out-of-school steps without contextual adjustment can lead to the punishment of students who lack the means to do so. AlSayegh et al. (2023) identified relationships between the

use of a fitness tracker and physical activities and adolescent health, but they cannot demonstrate that the results are the sole cause of healthier behaviour due to ownership. It can also display socioeconomic privilege, accustomed to digital gadgets, and family expectations.

There is also privacy. Depending on the device, PE data may provide insight into health conditions, body shape, inactivity, sleep, or place-based routines. Data privacy and ethical concerns emerged as significant concerns related to school PE in the study by Zhao and Su (2026). These issues are compounded when the data are distributed in dashboards, leaderboard-style, or teacher-managed applications. Students must understand what is collected, the purpose of such collection, with whom it can be shared, and how long. Assent and consent are not merely administrative. They determine whether wearable feedback is perceived by students as supportive or surveillant.

The practice of evidence implementation also cautions against the presumption of teacher preparedness. Almusawi et al. (2021) revealed that teacher integration was conditional on the perceived usefulness, ease of use, system access, and professional competence. Similar to Ferrier et al. (2022) and Khosravi et al. (2022), wearable technology-based learning technologies need to align device affordances with learning tasks and conditions of their implementation. This will require teachers working in PE to have routines on a practical distribution of devices, on problem solving with device syncing, reading data, privacy protection, and reflective tasks. Devoid of these routines, wearables may turn into distractions, symbols of status, or compliance devices. The most robust implementation plan is thus a humble one: begin with small formative cycles, keep student data confidential, rely on personal goals instead of rankings, and assess the extent to which feedback can enhance learning as opposed to simply generating more data.

Table 3. Pedagogical design principles for wearable feedback in school PE

Design principle	Recommended PE practice	Risk if ignored
Use personal mastery goals	Students should be asked to set baseline-informed, adjustable goals and explain their progress privately.	Public ranking may demotivate less active students and intensify comparisons.
Make feedback reflective	Pair tracker data with short learning logs, barrier analysis, and goal revision.	Students may chase numbers without learning self-regulation.
Use data formatively	Treat steps, active minutes, and heart rate zones as prompts for dialogue, not as direct grades.	Raw data may lead to unfair summative assessments.
Plan for maintenance	The teacher gradually faded and asked students to design activity routines without the device.	Behaviour gains may disappear when monitoring stops.
Protect privacy	Consent, data minimisation, and private feedback should be used by default.	Students may experience feedback as a form of surveillance rather than support.

Discussion

The review suggests that wearable feedback has a legitimate yet conditional role in school PE. Daily step counts showed the most consistent positive impact, although the impact on MVPA, sedentary behaviour, and long-term maintenance was inconsistently positive and mixed. This trend is not new, since most wearables are focused on making steps highly visible and easily rewarded, but in contrast to MVPA, it needs to be sustained consistently when conditions are right and motivation is provided. One of the critical readings is that wearables can be effective in initiating rather than maintaining more complex behaviour changes.

Of particular importance is the difference between successful PE-based interventions and those that are less effective, stand-alone, or lightly mediated. According to Guijarro-Romero et al. (2023, 2024) and Becerra-Fernández et al. (2025), wearable data can be used to enhance motivation and activity when embedded in autonomy-supportive teaching, adaptation goal setting, and structured reflection. Ridgers et al. (2021) and Verswijveren et al. (2022) warn that low engagement levels and a lack of change in

the social and instructional environments where students make activity choices reduce the effectiveness of apps, trackers, and online challenges. Mateo-Orcajada et al. (2024) also found that suitable promotion, even successful compulsory use, might not induce a sustained habit following the discontinuation of the promotion.

Next-generation research must eliminate step-count results and investigate learning processes, such as the quality of goals, reflective competence, perceived autonomy, post-removal assessment literacy, and maintenance. Second, PE research must not shun a comparison of various feedback designs, including but not limited to private mastery feedback, peer challenge, teacher counselling, and student-led goal review, but to pose the question: are wearables generally good? Third, ethical prudence should be exercised in school implementation. Privacy of data, device validity, and unequal access must be considered as fundamental design considerations. Wearable feedback has the potential to aid in self-regulated physical activity, although it must also be integrated into an educational system that

appreciates understanding, agency, and inclusiveness.

Conclusion and Implications

This review concludes that wearable trackers have the potential to become a valuable part of school physical education when used as a pedagogical feedback system rather than as a mere step-counting tool. Their key value is that they display activity and enable personal goal setting and student reflection on progress. However, visibility alone is not enough to ensure learning, motivation, or resulting behavioural change. Feedback in devices was most useful when teachers related the data of the devices with autonomy-supportive instruction, formative assessment, personalised goals, and reflective tasks. It also proved to be weaker when there was no long-term educational mediation, as the students were left to answer dashboards, competitions, or reminders.

The pragmatic point is that PE teachers need to enter wearable data not as a judgement of student achievement but as a point of

discussion. Raw steps, active minutes, and heart rate estimates must be interpreted in combination with student reflection, contextual barriers, movement competency, and enjoyment. Schools are also urged not to use public ranking systems which heighten competition or punish students with low chances of after-school activities. The issues of privacy, consent, data minimisation, and accuracy of devices should be addressed prior to the problems being realised rather than when they are realised.

In future studies, the most important aspect is to test feedback designs that develop lasting self-regulation once the device has been removed. Maintenance testing, equity-sensitive assessment models, and teacher professional development strategies should be tested. Wearables cannot serve as a quick fix for PE. They can only become useful when they reinforce the core learning outcomes of physical education: agency, understanding, inclusive engagement, and life-long involvement with physical activities.

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