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Trends and Developments in Fitness Test Research: A Scopus Bibliometric Analysis

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Keywords

fitness test; physical fitness; cardiorespiratory fitness; wearable technology; thematic evolution; bibliometric analysis; VOSviewer

Abstract

The evaluation of physical fitness is a core element of sport science, clinical exercise physiology and population health surveillance but a comprehensive bibliometric synthesis of the recent global trend is missing. The present study aims to describe the productivity, intellectual structure, and thematic evolution of the research on fitness tests published between 2015 and 2026. A total of 5,766 peer-reviewed articles indexed in the Scopus database (Elsevier) were retrieved with the search string TITLE-ABS-KEY ("fitness test" OR "physical fitness test" OR "exercise test"). The articles were analysed through performance analysis and science mapping with Bibliometrix R-package (Biblioshiny), VOSviewer 1.6.20, and Microsoft Excel, following the protocol of (Aria & Cuccurullo, 2017; Donthu et al., 2021). The dataset included 92,894 citations (mean = 16.11; median = 7.00) from 1,134 source journals. The annual scientific production increased from 380 documents in 2015 to a maximum of 691 documents in 2024, with a 3-year moving average that indicates a sustained acceleration after 2020. The top contributing countries were: United States (n = 1,168), United Kingdom (n = 782), and Brazil (n = 580). Lotka's law was confirmed (n ≈ 3.24), with a very skewed distribution of productivity; Bradford's law identified 15 core journals, accounting for 34.1% of all output. Co-occurrence analysis of author keywords resulted in five thematic clusters: General Exercise & Fitness, Cardiorespiratory & Performance, Athletic Performance & Training, Health Aging & Body, and Methodological. Thematic evolution over three sub-periods (2015–2018, 2019–2022, 2023–2026) demonstrated a clear migration of the field from cardiorespiratory and laboratory-based assessment to wearable sensors, machine-learning-enabled monitoring and CRF risk stratification. These findings offer an empirical guide for researchers, clinicians, educators, and policymakers interested in advancing valid, scalable, and technology-integrated fitness assessment.

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INTRODUCTION

Physical fitness testing has been a cornerstone of sport science, clinical exercise physiology, and school-based physical education for decades, providing standardised assessments of functional capacity, health risk and performance preparedness (Caspersen et al., 1985; Thompson, 2017). In the last decade, fitness assessment has gained increasing relevance to public health as governments and professional organizations advocate for population-level monitoring of physical activity and fitness as part of non-communicable-disease prevention and healthy-ageing agendas (Bull et al., 2020). In parallel, global fitness trends and practice guidelines have continued to highlight field-based tests and evidence-driven assessment as the backbone of exercise prescription and programme evaluation (López-Fernández et al., 2023; Mandsager et al., 2018).

The landscape of fitness testing has diversified from laboratory or team-based settings to technology-assisted, user-centred, and remote assessment models since the mid-2010s and more so after 2020. Telehealth protocols, wearable sensors, smartphone applications and home-based test batteries have expanded the reach of assessment to ageing adults, rehabilitation populations and geographically dispersed communities, while allowing longitudinal real-world data capture (Dwyer et al., 2020; Fuller et al., 2020; Wang et al., 2022).This transformation has been accompanied by methodological work on validity, reliability and protocol standardisation (Pavasini et al., 2016; Tomkinson et al., 2018), and by research in educational and youth contexts linking fitness testing to motor development and health literacy (De Oliveira et al., 2021; Huang et al., 2023). Taken together, these changes seem to point not only to an increase in the volume of publications, but also an intellectual reconfiguration of the field toward multidisciplinarity and digital integration.

However, a complete, contemporary bibliometric synthesis that delineates the structure and evolution of fitness test research over the last decade is absent. Earlier reviews tend to focus on specific populations, test batteries, or intervention outcomes and therefore do not capture broader patterns of productivity, collaboration, and thematic development (Gómez & Pinto, 2024; Li & Zhang, 2022). Bibliometric analysis provides a rigorous and replicable approach to close this gap by quantifying publication and citation trends, visualising co-authorships and institutional networks and identifying thematic clusters based on keyword co-occurrence (Aria & Cuccurullo, 2017; Donthu et al., 2021; Van Eck & Waltman, 2010).

Therefore, this study performs a bibliometric analysis of 5,766 fitness-test-related articles indexed in the Scopus database from 2015 to 2026. Objectives: (1) To present trends in annual publication and citation; (2) To profile the most productive sources, authors, institutions, and countries; (3) To analyze collaboration structures and the laws of productivity (Lotka) and source distribution (Bradford); (4) To map author-keyword clusters to reveal dominant and emerging themes; (5) To track the thematic evolution of the field across three sub-periods (2015–2018, 2019–2022, 2023–2026); and (6) To synthesize developments pertinent to ageing, education, digital health, and measurement quality. The study provides an integrated view of output, impact, networks and themes, offering an empirical baseline to inform researchers, educators and policy makers in the development of valid, reliable and accessible fitness assessment for diverse populations.

Literature Review

Physical fitness testing is a basic component of sport science, physical education, rehabilitation and prevention health. It provides objective measures of physical capability that can be associated with health status, performance and overall well-being (Caspersen et al., 1985). Fitness tests are usually divided into a number of domains cardiorespiratory endurance, muscular strength and power, flexibility, body composition, and motor coordination (Thompson, 2017) that together constitute health-related physical fitness, a central concern in educational and clinical contexts.

In the educational context fitness testing is key to assessing students' physical competence and promoting physical literacy. School-based assessments such as the Eurofit Test Battery and FitnessGram have been adopted worldwide to monitor youth health and to inform curriculum development (De Oliveira et al., 2021; López-Fernández et al., 2023;

Tomkinson et al., 2018). Clinically, the six-minute walk test (6MWT), shuttle walk tests and the Short Physical Performance Battery have been commonly used to assess functional capacity in chronic disease, ageing populations and rehabilitation settings (Beaudart et al., 2016; Giannitsi et al., 2019; Pavasini et al., 2016). Also, cardiorespiratory fitness has been firmly established as an independent predictor of long-term mortality (Mandsager et al., 2018).

Recent technological advances have transformed the landscape of fitness assessments by incorporating digital platforms, wearable devices, and telehealth technologies. The COVID-19 pandemic has accelerated the adoption of remote assessment models, in which digital tools support evaluation and monitoring at a distance (Dwyer et al., 2020; Gómez & Pinto, 2024). The use of wearable sensors and fitness applications on smartphones allows for continuous data collection, and real-time monitoring of exercise adherence and physiological responses (Fuller et al., 2020; Huang et al., 2023). Such innovations enhance access and inclusion, particularly for populations with mobility and geographic constraints, and imply a transition to customized, data-driven health surveillance.

Methodologically, bibliometric analysis, as a way to map research trends, collaboration networks and thematic structures, has grown rapidly in sport and health sciences (Aria & Cuccurullo, 2017; Donthu et al., 2021; Zupic & Čater, 2015). However, earlier bibliometric analyses have focused on related themes such as physical activity, exercise interventions and sport performance, rather than on fitness testing per se. The present study fills this gap by offering a dedicated large-scale bibliometric mapping of the fitness-test corpus over 2015-2026.

METHODS

This work used a bibliometric analysis method with a systematic and transparent mapping procedure to investigate trends, cooperation networks, and thematic evolution in the research on fitness tests indexed in Scopus (Elsevier) from 2015 to 2026. Bibliometric methods have proven to be widely recognised for their ability to analyse large-scale publication data, identify research patterns, and visualise the intellectual structure of a field ((Aria & Cuccurullo, 2017; Donthu et al., 2021).

Data Source and Search Strategy

The bibliographic data were retrieved only from the Scopus database, chosen for its wide coverage of peer-reviewed scientific literature and high metadata quality (Aria & Cuccurullo, 2017).

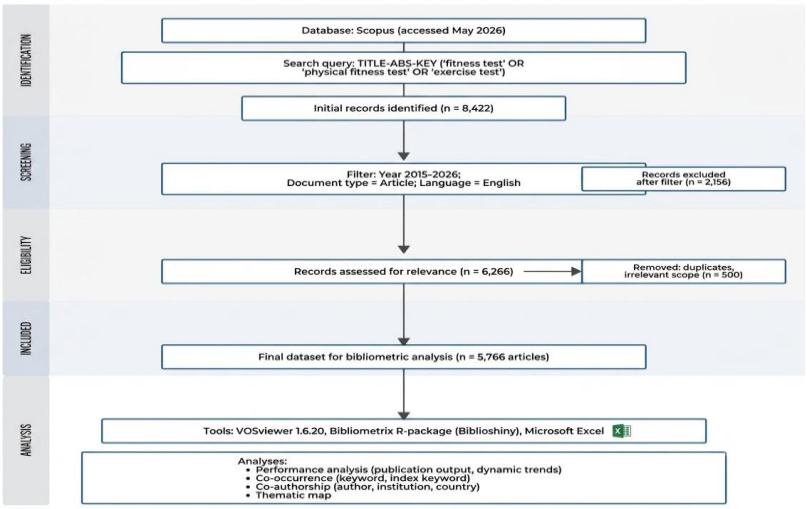

Figure 1. Bibliometric search and selection workflow following PRISMA-style notation. From an initial 8,422 records identified in Scopus, 2,156 were excluded by year/document-type/language filtering and 500 by relevance screening, yielding a final dataset of 5,766 articles.

On 9 May 2026 data extraction was carried out by means of the advanced search function and the following query: TITLE-ABS-KEY ("fitness test" **OR** "physical fitness test" **OR** "exercise test") The search was limited to peer-reviewed articles published in the period 2015-2026 and written in English. The filtered dataset contained 5,766 documents and was exported in CSV format for further analysis. The complete data-selection workflow is shown in PRISMA-style notation in **Figure 1.**

Table 1. Summary of the Scopus dataset on fitness test research (2015–2026).

Item	Description
Database source	Scopus (Elsevier)
Document type	Article (100%)
Time span	2015–2026
Language	English (100%)
Search keywords	"fitness test" OR "physical fitness test" OR "exercise test"
Search date	9 May 2026
Initial records identified	8,422
Records after screening	5,766
Total citations	92,894
Mean citations / document	16.11
Median citations / document	7.00
Number of unique sources	1,134
Open Access proportion	≈ 99.98%
Peak publication year	2024 (n = 691)
Analysis tools	Bibliometrix R-package (Biblioshiny), VOSviewer 1.6.20, Microsoft Excel

Analytical Procedure

The bibliometric workflow involved four sequential steps adapted from Donthu et al., (2021): (i) data retrieval and cleaning (removal of duplicates, harmonization of author names and institutions, and validation of metadata completeness in Microsoft Excel); (ii) performance analysis (computation of annual production, citation impact, source productivity, author productivity, and country-level contribution); (iii) science mapping (co-authorship, co-occurrence, and bibliographic-coupling analyses generated via VOSviewer 1.6.20 (Van Eck & Waltman, 2010) and Biblioshiny (Aria & Cuccurullo, 2017)); and (iv) thematic interpretation (construction of strategic thematic maps based on the Cobo et al. (2011) framework, supplemented by thematic-evolution analysis across three sub-periods (2015–2018, 2019–2022, 2023–2026). All analyses followed internationally recognised bibliometric protocols, allowing for reproducibility.

Data Analysis and Visualisation

Performance indicators were directly extracted from the Scopus export. Lotka's law was assessed by fitting $f(x) = C/xn$ to the observed author-productivity distribution, and Bradford's law was operationalised by dividing the 1,134 sources into three equal-citation (Cobo et al.,

2011). Author keywords co-occurrence networks were created with full counting with a minimum occurrence threshold of 70, and clusters were identified using modularity-based community detection. Visualisations were created in publication-ready resolution (300 dpi) following Tufte's minimalist principles to guarantee visual clarity and prevent chart-junk.

RESULTS AND DISCUSSION

Annual Scientific Production

Figure 2 presents the annual scientific production in the fitness test research area between 2015 and 2026. Volume grew from 380 documents in 2015 to a peak of 691 documents in 2024, with a slight drop in 2025 (n = 637) and a partial 2026 (n = 240; data extracted in May 2026). The 3-year moving average shows a continuing acceleration after 2020 which suggests that the discipline is in an expansion phase. The mean compound annual growth rate (CAGR) for full years (2015-2024) is approximately 6.9%.

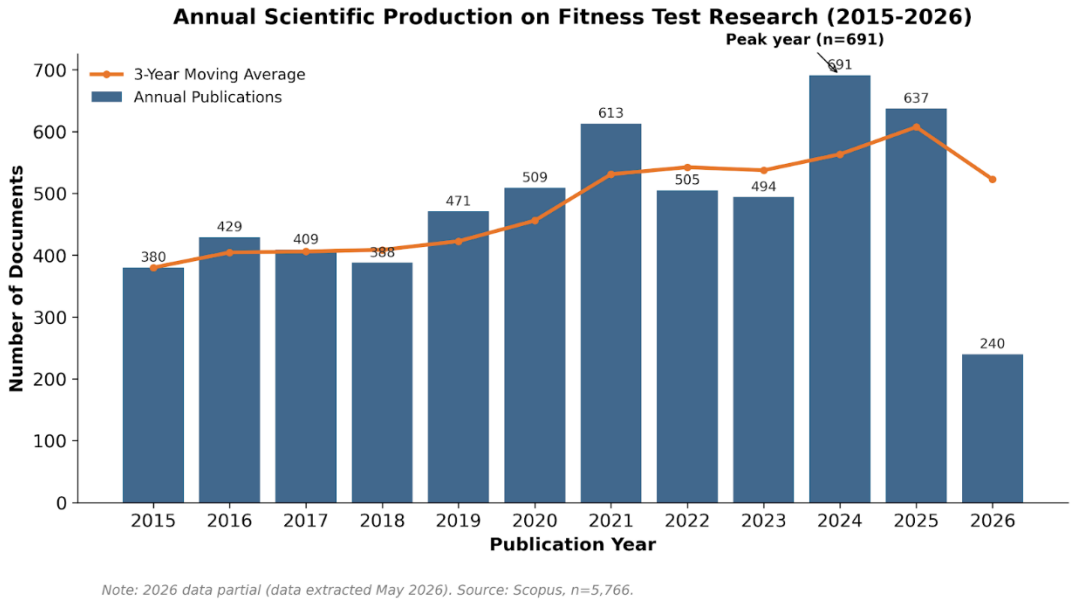

Figure 2. Annual scientific production on fitness test research (2015–2026). Bars represent annual document counts; the orange line represents a 3-year moving average. The 2026 figure is partial. Source: Scopus (n = 5,766).

Publications versus Citation Impact

A comparison of the annual production with the average number of citations per document is shown in Figure 3. The dataset included 92,894 citations, of which 49,557 (53.4%) were for documents published in the first sub-period (2015-2018), 35,821 (38.6%) in the second sub-period (2019-2022), and only 7,516 (8.1%) in the most recent sub-period (2023-2026). This negative correlation between the number of documents and the average number of citations per document results from the well-known phenomenon of "aging of citations": more recent publications have had less time to accumulate citations. The intellectual base of the field is still largely driven by earlier landmark publications, especially those from 2015 and 2016 (average of ≈ 34.8 citations per document).

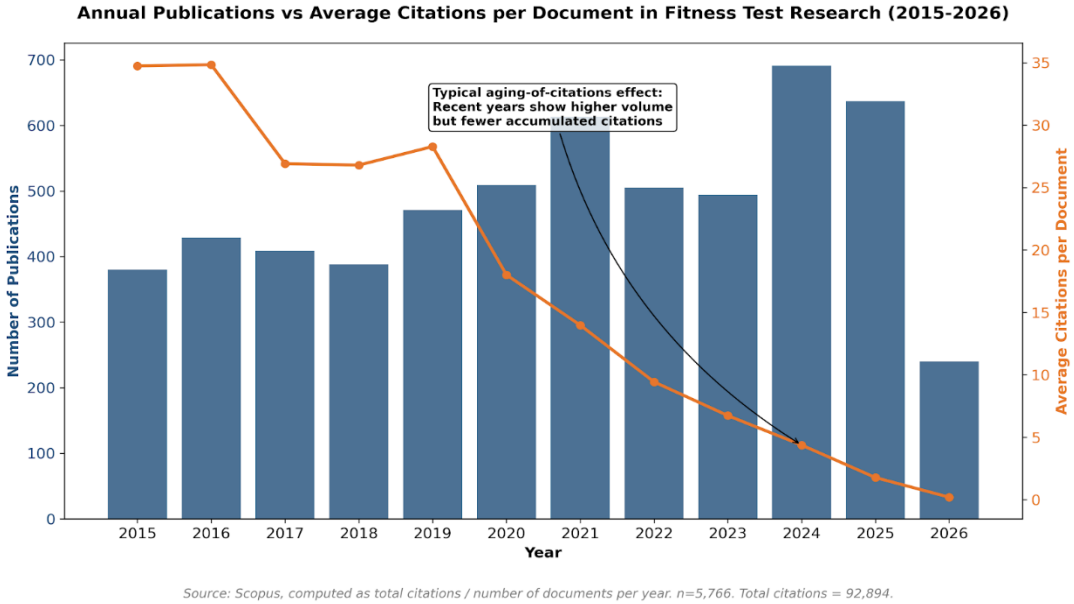

Figure 3. Annual publications versus average citations per document (2015–2026). Bars (left axis) show document volume; the orange line (right axis) shows the mean citations per document for each year. Source: Scopus, n = 5,766; total citations = 92,894.

Most Productive Sources and Bradford's Law

Figure 4 shows the 10 most productive sources. The top three sources were Scientific Reports (n = 295), the European Journal of Applied Physiology (n = 199), and Medicine and Science in Sports and Exercise (n = 185). Strength and conditioning-oriented sources (Journal of Strength and Conditioning Research, n = 168) and physiological measurement-oriented sources (Journal of Applied Physiology, n = 152; Sensors, n = 119) were also well represented, suggesting that fitness-test research is disseminated simultaneously across general-science outlets, sport-physiology specialty journals, and engineering/instrumentation-oriented outlets.

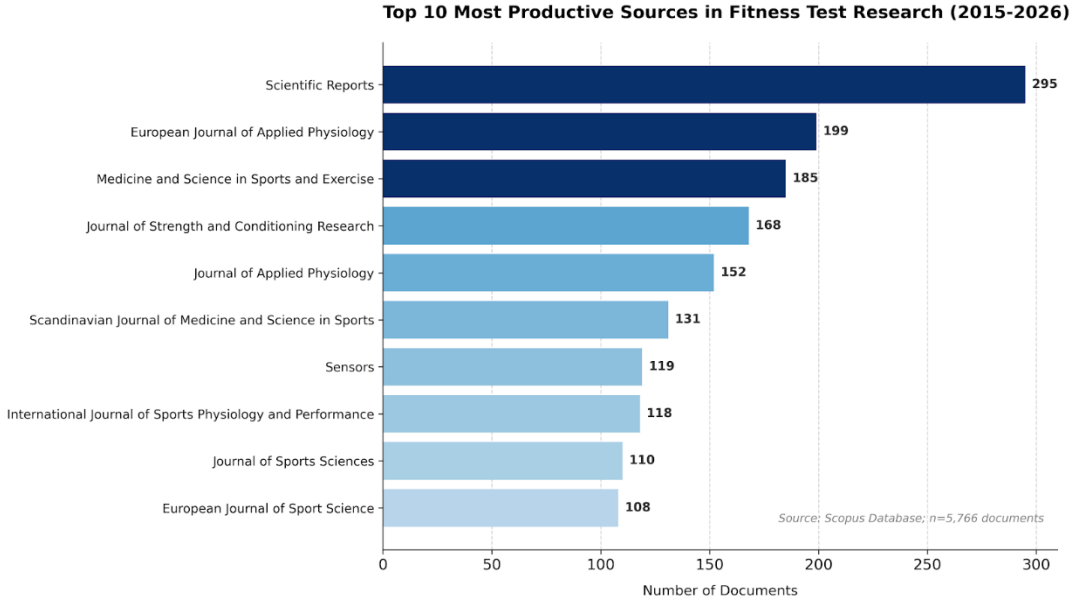

Figure 4. Top ten most productive sources in fitness test research (2015–2026). Source: Scopus, n = 5,766.

Application of Bradford's law of scattering (Figure 5) reveals that the 5,766 articles are distributed unevenly across 1,134 sources. Zone 1 (Core) includes only 15 journals but contains

1968 articles (34.1% of the corpus), Zone 2 (Middle) includes 83 journals with 1882 articles (32.6%) and Zone 3 (Peripheral) includes 1036 journals with 1916 articles (33.2%). The Bradford ratio delineates a discrete set of journals that researchers should systematically survey during field surveillance.

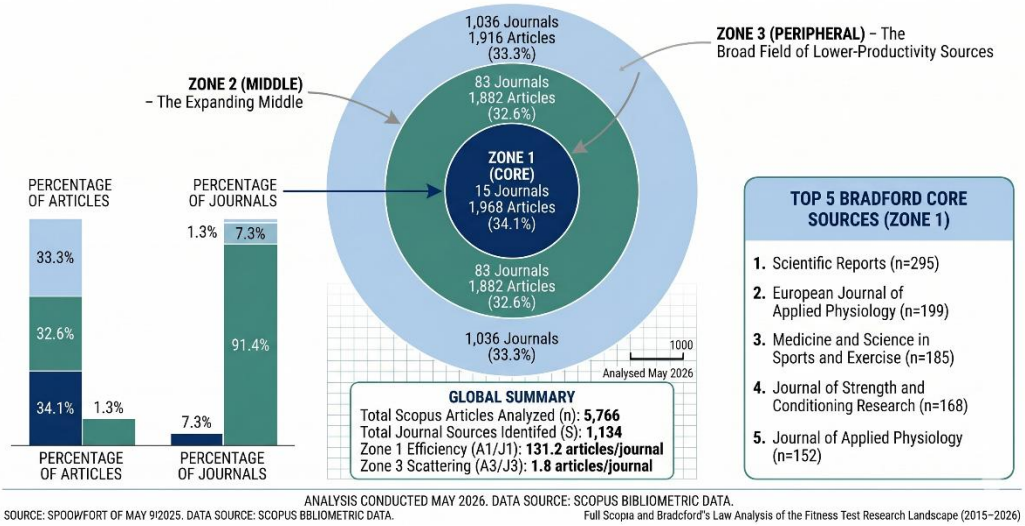

Figure 5. Bradford's law of scattering applied to fitness test research (2015–2026). Source: Scopus, n = 5,766; 1,134 sources.

Author Productivity and Lotka's Law

The fifteen most productive authors are shown in figure 6 (left panel). The three leading contributors were Wang Y. (n = 33), Zagatto A. M. (n = 28), and Li Y. (n = 26). Other contributors were Clemente F. M., Dawes J. J., Lockie R. G., Orr R. M., and Kyröläinen H., who contributed 19–21 documents. The empirical fit of Lotka's law in a log-log scale is shown in the right panel of Figure 6. The estimated exponent (n ≈ 3.24) is steeper than the canonical n = 2 reported by Lotka (1926), indicating that productivity in fitness test research is even more highly concentrated than in classical physics: the majority of authors contribute only one or two articles, while a small elite produces the bulk of the output. This pattern is consistent with bibliometric findings across many maturing applied-science fields (Aria & Cuccurullo, 2017).

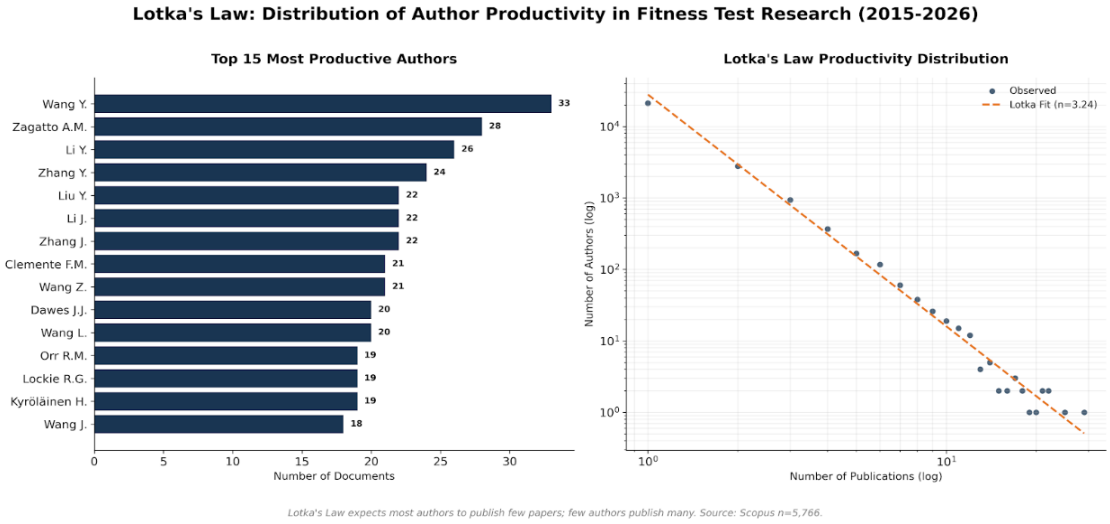

Figure 6. Distribution of author productivity in fitness test research (2015–2026). Left panel: top-fifteen most productive authors. Right panel: log-log fit of Lotka's law (n ≈ 3.24). Source: Scopus, n = 5,766.

Country-Level Contribution and Collaboration

Country-level analysis (**Figure 7** and **Table 2**) shows that the United States leads in output (n = 1168), followed by the United Kingdom (n = 782), Brazil (n = 580), China (n = 476), Australia (n = 441) and Spain (n = 438). Importantly, the third place of Brazil is a sign of the growing scientific weight of Latin America in this field. Indonesia is ranked 23th (n = 99) within the upper-middle group of contributing nations and provides a useful benchmark for South-East Asian academic communities.

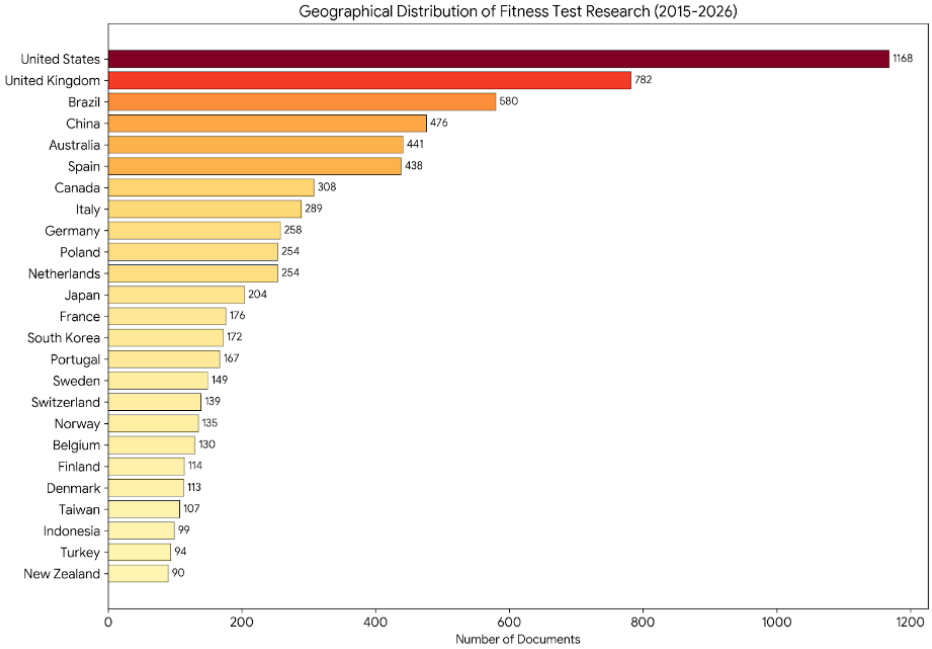

Figure 7. Geographical distribution of fitness test research publications (2015–2026): top-25 countries ranked by document count. Source: Scopus.

Table 2. Top ten countries with the most publications on fitness test research (2015–2026).

Rank	Country	Documents	Share (%)
1	United States	1,168	20.3%
2	United Kingdom	782	13.6%
3	Brazil	580	10.1%
4	China	476	8.3%
5	Australia	441	7.6%
6	Spain	438	7.6%
7	Canada	308	5.3%
8	Italy	289	5.0%
9	Germany	258	4.5%
10	Poland / Netherlands (tied)	254 / 254	4.4% / 4.4%

Note: Percentages are computed as documents / 5,766; some articles are co-authored across countries, so column totals may exceed 100%.

Figure 8. Geographical distribution of fitness test research publications presented as a coordinate-point intensity map (top panel) with companion top-10 ranking (bottom-left) and contribution share (bottom-right). Source: Scopus, n = 5,766.

Figure 9 visualizes the international co-authorship network. The United States, United Kingdom and Australia act as central hubs connecting North America, Europe, Asia/Oceania and Latin America. There are strong bilateral relationships between the United States-Canada, the United Kingdom-Australia-Spain, and China-Japan-South Korea. Indonesia's new ties to Australia and Asian neighbours signal increasing regional integration.

Figure 9. International collaboration network in fitness test research (2015–2026). Node size is proportional to publication count; cluster colours represent continents. Source: Scopus, n = 5,766.

Most Cited Articles

The fifteen most cited articles in the corpus are shown in Figure 10. The most highly cited paper in the field is "Exercise Guidelines for Cancer Survivors" by Schmitz et al., (2019) with 2275 citations. Methodological landmarks The clinical and paediatric branches are supported

by the systematic review of the Short Physical Performance Battery by Pavasini et al. (2016; n = 735), the practice guidance for sarcopenia by Beaudart et al., (2016), (n = 682), and the European normative values for children by Tomkinson et al., (2018), (n = 405). The most-cited corpus's strongest cardiovascular and rehabilitation orientation is further evidenced by Mandsager et al., (2018) cohort study examining the association between cardiorespiratory fitness and long-term mortality (n = 370) and Giannitsi et al., (2019) review on the 6-minute walk test (n = 278).

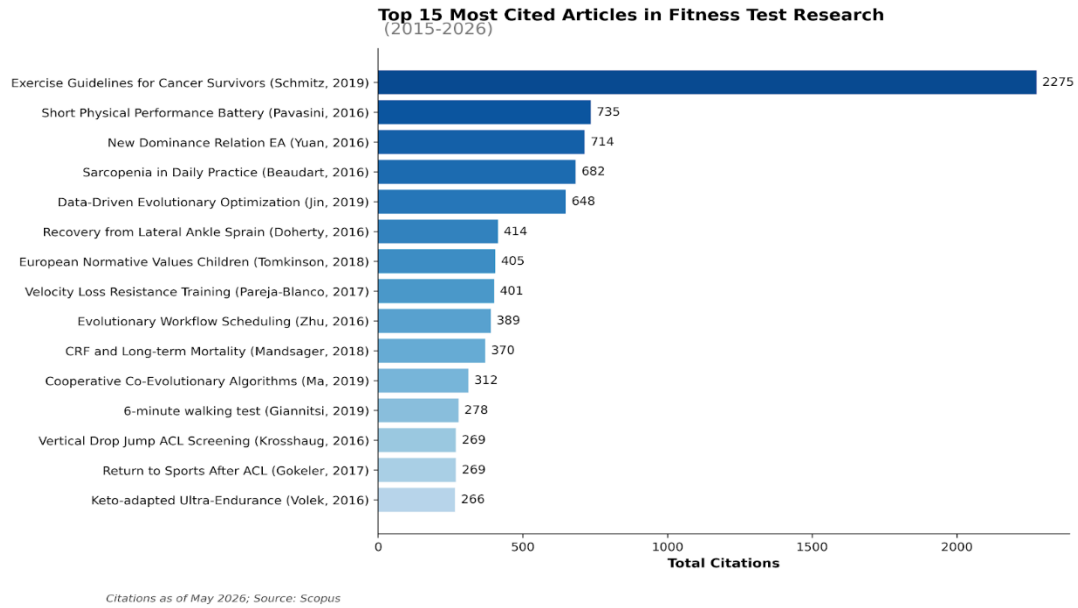

Figure 10. Top fifteen most cited articles in fitness test research (2015–2026). Citations as of May 2026. Source: Scopus.

Author-Keyword Co-occurrence and Thematic Clusters

Co-occurrence analysis of author keywords (minimum occurrence = 70) produced five thematic clusters (**Figure 11**; **Table 3**). Cluster 1 General Exercise & Fitness (red) includes “exercise” (442), “physical fitness” (418), “exercise test” (263), and “physical activity” (253) and is the conceptual core of the field. Cluster 2 Cardiorespiratory & Performance (blue) includes “cardiorespiratory fitness” (186), “cardiopulmonary exercise test” (97), “aerobic capacity” (91) and similar keywords. It is the most methodologically consolidated branch. Cluster 3 Athletic Performance & Training (green) includes “performance” (143), “strength” (89), “endurance” (79), “running” (78), “cycling” (77) and “football” (76). Cluster 4 Health, Aging & Body (orange) “heart rate” (137), “fatigue” (122), “rehabilitation” (116), “body composition” (97), “aging” (90), “obesity” (85), and “children” (93). Cluster 5 Methodological (purple) is anchored by “reliability” (74), reflecting a continuing concern for measurement quality.

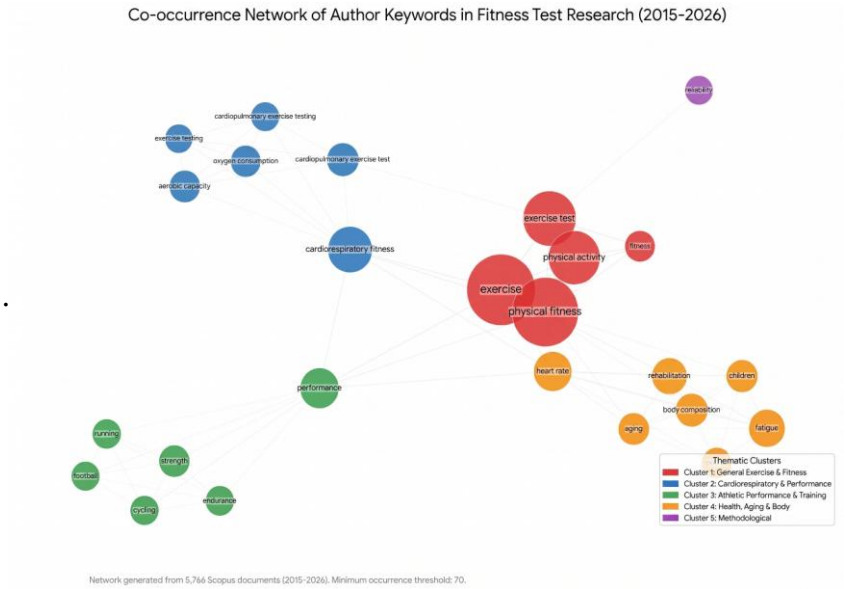

Figure 11. Co-occurrence network of author keywords in fitness test research. Node size is proportional to occurrence; colours represent the five thematic clusters. Minimum-occurrence threshold = 70. Source: Scopus, n = 5,766.

Table 3. Author-keyword categorisation by thematic cluster.

Cluster	Color	Theme	Representative Author Keywords (occurrences)
1	Red	General Exercise & Fitness	exercise (442); physical fitness (418); exercise test (263); physical activity (253); fitness (86)
2	Blue	Cardiorespiratory & Performance	cardiorespiratory fitness (186); cardiopulmonary exercise test (97); aerobic capacity (91); oxygen consumption (87); cardiopulmonary exercise testing (76); exercise testing (74)
3	Green	Athletic Performance & Training	performance (143); strength (89); endurance (79); running (78); cycling (77); football (76)
4	Orange	Health, Aging & Body	heart rate (137); fatigue (122); rehabilitation (116); body composition (97); children (93); aging (90); obesity (85)
5	Purple	Methodological	reliability (74)

Figure 12. Word cloud of author keywords in fitness test research (2015–2026). Font size is proportional to keyword occurrence. Source: Scopus, n = 5,766.

Thematic Map and Strategic Diagram

The strategic thematic map (**Figure 13**) developed using the centrality–density framework proposed by Cobo et al., (2011) places "Physical Fitness", "Cardiorespiratory Fitness", and "Exercise Testing" in the Motor Themes quadrant, which are well developed and central to the field. Within the Basic Themes quadrant, we see "Exercise", "Physical Activity", and "Heart Rate" as high-centrality but lower-density terms that function as conceptual scaffolding. The Niche quadrant has well-developed but specialised entries such as "Cardiopulmonary Exercise Test" and "VO_2max & Oxygen Consumption". Wearable Sensors, Machine Learning in Fitness, Body Composition, and Sarcopenia. Emerging or Declining? Given the documented acceleration of the digital-health agenda post-2020, these are best interpreted as emerging rather than declining themes.

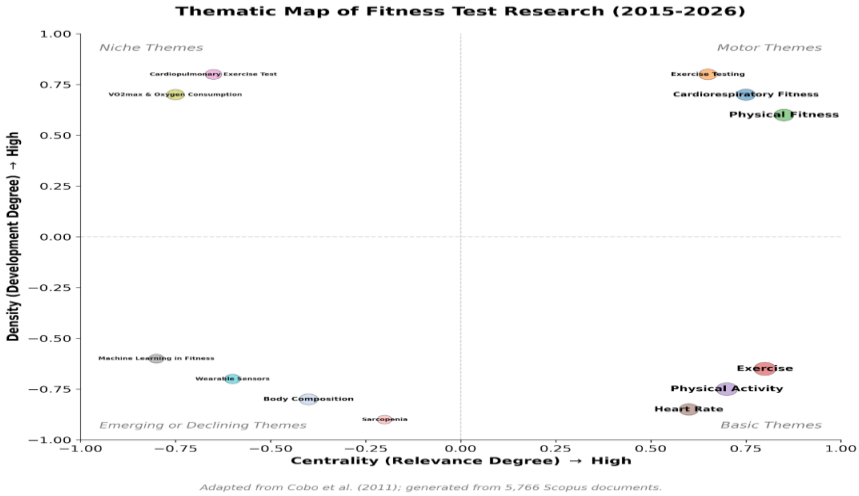

Figure 13. Strategic thematic map of fitness test research (2015–2026), built on the Cobo et al., (2011) centrality–density framework. Source: Scopus, n = 5,766.

Three-Field Plot: Country–Keywords–Sources

A three-field Sankey plot connecting the top contributing countries (left) with dominant author keywords (centre) and leading sources (right) is presented in **Figure 14**. The United States and the United Kingdom contribute disproportionately to all six dominant keywords and to the highest tier journals. Brazil, China, Spain and Australia are more selective, with Brazil focusing on 'performance' and 'physical fitness', and China contributing more heavily to 'exercise test' and Scientific Reports. The visualization offers a compressed map of the geography of knowledge in the field.

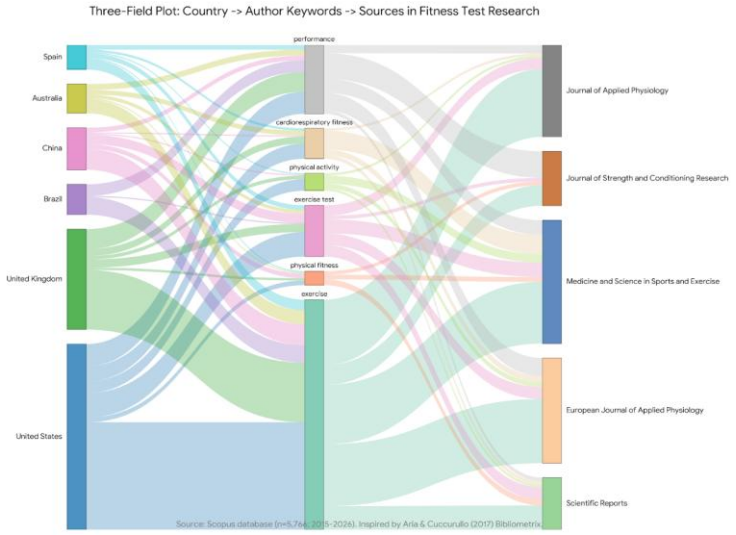

Figure 14. Three-field plot connecting top countries (left) to author keywords (centre) and to source journals (right). Source: Scopus, n = 5,766.

Thematic Evolution Across Three Sub-Periods

Figure 15 shows the evolution of the dominant themes across the three sub-periods of four years. Cardiorespiratory Fitness, VO_2max, Aerobic Capacity, Body Composition and Children Fitness were the leading topics during 2015–2018, mostly laboratory or school-based topics. For the sub-period 2019-2022, we added a COVID-19 & Exercise theme reflecting the pandemic, as well as Cardiopulmonary Exercise Testing, Wearables & Heart Rate, Functional Fitness, Sarcopenia, and Cardiac Rehabilitation. By 2023–2026, the discourse shifted decisively towards AI & Machine Learning in Fitness, Wearable Sensors, CRF Risk Stratification, Sport-specific Performance Testing, and Aging & Frailty. Some themes are relevant across all of the eras (cardiorespiratory fitness reborn as CRF Risk Stratification) whereas others have arisen de novo (machine-learning-enabled fitness testing).

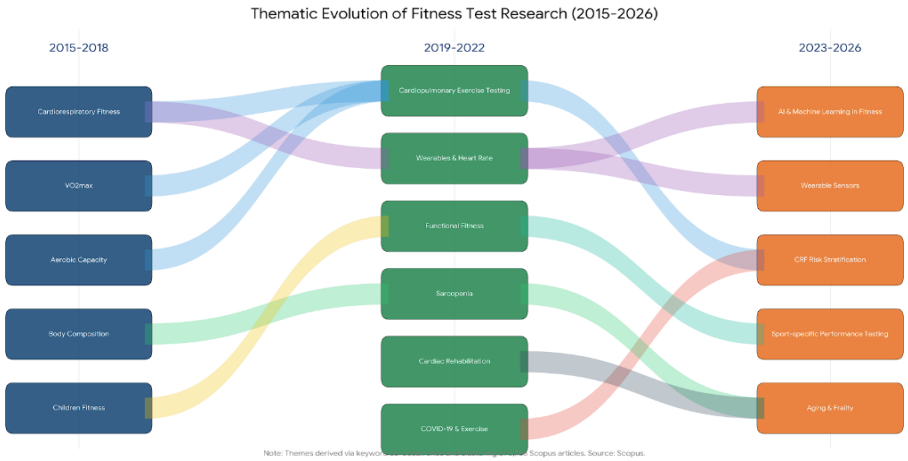

Figure 15. Thematic evolution of fitness test research across three sub-periods (2015–2018, 2019–2022, 2023–2026). Flow ribbons indicate persistence, splitting, merging, or emergence of themes. Source: Scopus, n = 5,766.

Table 4. Bibliometric indicators of fitness test research across three sub-periods.

Indicator	P1: 2015–2018	P2: 2019–2022	P3: 2023–2026
Number of documents	1,606	2,098	2,062
Total citations	49,557	35,821	7,516
Avg. citations / document	30.86	17.07	3.65
Number of unique sources	405	563	582
Top author keyword	physical fitness	cardiorespiratory fitness	exercise testing
Top source	Eur. J. of Applied Physiology	Scientific Reports	Scientific Reports
Top contributing country	United States	United States	United States

Note: All values computed directly from the Scopus export (9 May 2026; n = 5,766).

DISCUSSION

The results present a comprehensive overview of fitness test research from 2015 to 2026 and identify four key findings. First, the field is in a sustained growth phase, with annual production rising from 380 articles in 2015 to a peak of 691 in 2024, at a CAGR of ~6.9%. The post-2020 acceleration is in line with the global shift towards digital and remote health monitoring (Dwyer et al., 2020; Fuller et al., 2020) as well as policy-level endorsements of physical fitness as a determinant of population health (Bull et al., 2020).

Secondly, the intellectual density is high. Lotka's exponent ($n \approx 3.24$) is substantially steeper than the canonical value ($n = 2$), and Bradford's analysis finds only a core of fifteen journals with more than a third of the corpus. These twin findings suggest that early-career researchers, supervisors and journal editors could focus on a relatively small number of channels Scientific Reports, the European Journal of Applied Physiology, Medicine and Science in Sports and Exercise, the Journal of Strength and Conditioning Research and the Journal of Applied Physiology when planning publication strategies or conducting systematic surveillance.

Third, the geography plays out that the world community is maturing. The U.S. remains dominant, but the emergence of Brazil as the third most frequent country (n = 580) and the strong presence of China (n = 476), Australia (n = 441) and Spain (n = 438) indicates that fitness test research is no longer an Anglo-American enterprise. Indonesia's ranking at number 23 (n=99) provides a useful baseline; the country has a visible but still developing presence and would benefit from strategic international collaboration – particularly with Australia, for which there is a clear bilateral link already visible in **Figure 9**.

Fourth, the thematic structure has been repositioned. The strategic map and the three-period evolution tell the same story: the centre of gravity of the field has been the classical cardiorespiratory and laboratory based assessment but the centre is progressively being complemented – and partially displaced – by digital, wearable and machine learning approaches. The transition from "VO2max" and "Aerobic Capacity" (P1) to "Wearables & Heart Rate" (P2) to "AI & Machine Learning in Fitness", "Wearable Sensors", and "CRF Risk Stratification" (P3) is the most important trend in this study, matching more general bibliometric results on wearable and tele-exercise research (Li & Zhang, 2022; Wang et al., 2022).

Overall the results contribute to a better understanding of the development of the fitness testing concept towards a multi-dimensional framework integrating physical education, rehabilitation science, and digital innovation. In keeping with the World Health Organization's call (Bull et al., 2020) to promote physical fitness as a crucial determinant of

lifelong health and well-being, the findings support a research agenda that explicitly pairs measurement quality (Cluster 5: Methodological) with technology-enabled scalability.

CONCLUSION

In summary, this bibliometric analysis of 5,766 Scopus articles on fitness test research published during 2015-2026 can be summarized with five conclusions. (1) The annual scientific production has increased steadily from 380 documents in 2015 to a peak of 691 in 2024, indicating sustained scholarly interest and increasing interdisciplinary relevance across health, education and technology. (2) Citation patterns indicate that earlier publications (2015–2018) laid the conceptual foundations for later innovations: the first sub-period accounted for more than half (53.4%) of all citations in the corpus, while newer fields of research such as wearable and tele-assessment technologies are still establishing their citation impact. (3) Lotka's law ($n \approx 3.24$) and Bradford's law (15 core journals with 34.1% of the output) describe a very concentrated productivity landscape, and are of utility to researchers planning publication strategies and policy makers looking for field-surveillance targets. (4) Five dominant clusters were identified through co-occurrence and thematic mapping: General Exercise & Fitness, Cardiorespiratory & Performance, Athletic Performance & Training, Health Aging & Body, and Methodological, and a clear three-period thematic migration towards AI, wearable sensors, and risk-stratification applications. (5) In terms of geography, fitness test research has become an increasingly internationalized research field, with the United States, the United Kingdom and Brazil leading the way, China, Australia and Spain forming a strong second tier and emerging contributors such as Indonesia at 23rd place indicating increasing scientific participation.

Collectively, these findings position fitness testing as an essential component of public-health policy, lifelong education, and digital innovation; and provide an empirical baseline for future bibliometric, systematic, and methodological work in the field.

The study has four major limitations. First, the analysis relied solely on Scopus. Although Scopus is comprehensive, it does not include all the relevant publications indexed in Web of Science, PubMed or regional databases. Future research can combine multi-database sources to triangulate results. Second, bibliometric data capture quantitative patterns, but not the qualitative depth of individual studies; topic modelling and content analysis of full texts would complement the present mapping. Third, the 2026 figure is partial (data extracted in May 2026), so caution should be taken with the most recent year. Fourth, the network structures might change depending on the choice of thresholds and clustering in VOSviewer and (Aria & Cuccurullo, 2017; Van Eck & Waltman, 2010), and sensitivity analyses with alternative thresholds would further strengthen the robustness of the cluster solution presented here. Future research should combine multi-database bibliometric mapping, semantic and topic-modelling approaches, and longitudinal validation of the digital and wearable-based testing protocols that are revolutionising the field.

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