

Influential Research Articles Involving Physical Education: A Bibliometric Analysis

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Abstract

Physical education's knowledge base and the research of it has seen growth over the past 30 years. With growth in research outputs, there is an incentive to dissect the knowledge base in systematic ways to gain a broader, more complete understanding. The general aim of this study was to conduct a bibliometric analysis of research studies that involved physical education. The primary bi-product of this analysis is a top 100 list of influential research articles that involved physical education which have accumulated the most citations. Analysis of the top list revealed influential articles, most active authors, prominent topics of inquiry, and common methodological approaches. A primary result was a prominence of cross-disciplinary research on the top 100 list representing over 80% of the articles. Topics such as physical activity, obesity prevention, and motivation were well represented on the top 100 list. Physical education is an academic subject that crosses disciplinary lines. Motor learning, exercise physiology, public health, and pedagogy are just some of the fields that intersect within the physical education setting. The top 100 list is populated with research articles that have important insights into best practices, theoretical constructs, and proven methods to help advance the field forward.

Keywords: Physical education, knowledge base, bibliometric analysis, Influential research

1. Introduction

The field of physical education and its research productivity has seen extraordinary growth over time (Marttinen et al., 2017). An international pool of scholars has spurred the advancement and disseminated research on a range of topics, reflecting the cross-disciplinary nature of physical education, contributing to multiple aspects of human development, well-rounded education, and effective instruction (Every Student Succeeds Act, 2015; SHAPE America, 2013). These include, for instance, time and learning, assessment for learning, motor skill development, teacher feedback, curriculum and instructional models, gender stereotypes, race and ethnicity, professional development, policy, motivation, and public health in physical education (Kirk et al., 2006). With growth in the knowledge base, questions seldom arise about challenges surrounding a lack of information; instead, it is often an issue of surplus. Conducting reviews enables scholars to synthesize knowledge, provide an overview of the current state of knowledge, highlight gaps, and pinpoint future directions (Hulland & Houston, 2020).

Physical education scholars have conducted several forms of reviews to organize and further understand the knowledge base. Reviewing research articles can provide a multidimensional view of the knowledge base to members of a field (Kulinna, et al., 2009). These include, for example, literature reviews, scoping reviews, meta-analyses, and systematic reviews. One such example is a systematic review of research literature focused on physical education pedagogy (Kulinna et al., 2009). Other example reviews are evidenced by a systematic review paper that focused on public health recommendations for Physical Education Teacher Education programs (Webster et al., 2015) and a systematic review of research on cooperative learning in physical education (Bores-Garcia et al., 2020). Reviews of this form are typically conducted to understand and/or compare and contrast the findings of a specific, focused research topic (Grant et al., 2009).

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Another research review approach that offers a degree of novelty to the physical education field is a bibliometric analysis. A bibliometric approach extracts bibliographical information objectively and quantitatively (i.e., statistical evaluation) to help organize information on a particular topic for published articles, books, or the chapters of a book (Merigó et al., 2015). A key feature of the bibliometric approach is that it can sort through large data sets to locate articles that have imparted influence by totaling the number of citations (Priem, 2013). The approach can also yield information on citation frequency per year to elucidate the research's impact and overall quality. Average citation per year results allow the researchers to tease out emerging articles that have consistently drawn interest from the research community across years. The bibliometric analysis is a useful tool to pinpoint influential researchers, research papers, points of distribution, scholarly productivity, methodology, and topics of inquiry over time (Fahimnia et al., 2015). Across fields of study, it has emerged as a methodological approach to examine trends in scholarship such as medicine (Kelly et al., 2010) and physical activity (PA; Müller et al., 2016). To date, a few scholars have applied the bibliometric analysis approach in the field of physical education. A primary example is a recent bibliometric analysis that focused on instructional technology in physical education lessons (Calabuig et al., 2020).

With the growth of the field and broadened areas of foci in physical education research, conducting a bibliometric analysis from a broad perspective to provide a generalized understanding of influential scholars and topics that have garnered interest within and outside the field would be valuable to identify strengths, identify areas of growth, and indicate future directions as a field overall. The purpose of this study was to examine the trends and influence of the physical education knowledge base in the last three decades. Since this study focuses on scholarly impacts, we discuss the research's influence solely based on the number of citations. The last three decades are the study's focus to capture a sufficient duration of time to see the trends and changes in physical education research. Four research questions guided the study; (a) What are the impacts of research in physical education in the top 100 list (i.e., productive years of the impactful research, numbers of accumulated and average citations, and geographical locations); (b) What are the impacts of research among different research areas in the physical education top 100 list?; (c) Who are the most active authors and top journal outlets for the top 100 list?; (d) What are the trends of methodological approaches and research focus in each category of the research area within the top 100 list?

2. Methods

The researchers adopted a citation analysis approach for the bibliometric research methodology. Citation analysis is appropriate to measure a research article's influence (i.e., the most cited articles; Zupic & Cater, 2015). Such an approach also yields insights relating to the publication, the number of citations, citations over time, and geographical location. Importantly, a citation analysis represents a viable way to address and measure the impact of research articles in a field.

2.1 Research Data Platform

Researchers used the Web of Science (WoS; a product of Clarivate Analytics) Core Collection to identify influential physical education research articles in the last three decades. The WoS Core Collection is the most frequently adopted database for bibliometric analyses (Leng et al., 2013). The WoS platform enables searchers to customize the keywords and connect to regional indexes, conference proceedings, and over 30,000 journals (Clarivate, 2020). Web of Science also includes a Boolean Operator to customize the search options further. For example, placing quotation marks around a term (e.g., "physical education") ensures that the search will only produce results that contain that specific term. For the purpose of the study, we focused on any published research articles that contained physical education in the abstract, title, and/or the keywords using the field tag (TS – Topic and TI – Title) to locate research articles (Zupic & Cater, 2015).

2.2 Bibliometric Data Collection

To identify the top 100 most cited articles in the field, the research team determined the inclusion and exclusion criteria. A guiding principle was to approach physical education research from a broad, macro perspective, meaning, all research items that involved physical education were included. For example, a study that used the physical education setting and physical education students to conduct a study were deemed relevant. Mutual agreement on the parameters for inclusion criteria in the bibliometric analysis is imperative because the search often produces unwanted publications (Zupic & Cater, 2015). The final inclusion criteria were studies conducted involving physical education, a peer-reviewed article, a paper published between January 1, 1990, through December 10, 2020, and written in English. Exclusion criteria included a study outside of the physical education field, an article written in a non-English language, non-peer reviewed articles, and any study conducted before December 31, 1989.

Using the inclusion and exclusion criteria, the research members searched articles within the WoS database. The initial search process produced 17,748 items. Three members of the research team independently reviewed the bibliometric data (e.g., title, keywords, abstract) to ensure alignment with the inclusion and exclusion criteria. During this process, the goal was to identify the top 100 most cited articles independently. The dataset was sorted for independent review by total citations, with articles accumulating the most citations at the top of the list. Independent review then involved methodically moving through each article until the 100 most cited articles were identified. Following an independent review, three research team members compared the top 100 lists until mutual agreement was reached. Through identifying the top 100 list, 30 articles from the screening process were deemed unsuitable for inclusion in the study. Web of Science's downloaded data included the following information about each article: author, title, journal, date of publication, geographical location, and the abstract. All of this information was entered into a Microsoft Excel dataset to enable independent review by each research team member.

2.3 Data Analysis

Two steps were taken to analyze the bibliometric data. First, the researchers coded each article to identify substantive matters, methodological approaches of the articles, and geographical location. Second, the total number of citations and the average number of citations per year for the top 100 list were calculated over the last 30 years.

Data coding. Each research item was coded for its (a) substantive matters and (b) methodological approach. The article's substantive matters were coded based on the title and abstract of an article, all provided within the dataset generated by WoS. To strengthen understanding of the topical focus for each article, the research team deductively coded the top 100 list into six categories developed by Kirk and colleagues (2006): (a) theoretical perspectives, (b) cross-disciplinary, (c) learners and learning, (d) teachers, teaching, and teacher education, (e) physical education curriculum, and (f) differences and diversity (see Table 1 for the definitions and codes). Kirk and colleagues' (2006) categories served as the ideological framing for this study to provide a "view of knowledge about physical education pedagogy" (p. xi). If applicable, the research members assigned a collaborative category for an article (i.e., cross-disciplinary and physical education curriculum). For the methodological approach, the researchers recorded the information included in the WoS database to identify the type of paper (i.e., review paper) and/or reported the information described in the abstract.

Category	Code	Definition
Theoretical perspectives	Theory	Studies focused on scholars' view that broadly informs the research process and provides an orientation for systematic explanation.
Cross-disciplinary	Cross	Studies which have emphasis on range of disciplines (e.g., psychology, public health, sociology) that research inquiries in the physical education setting.
Learners and learning	L & L	Studies looked at student learning that prioritizes the relationships between physical education and its various components.
Teachers, teaching, and teacher education	T, T, & TE	Teachers, teaching, and teacher education encapsulates all research related to teachers, coaches, teacher educators, and teacher education.
Physical education curriculum	PE Curr.	Studies examined physical education curriculum.
Differences and diversity	Diff. & Div.	Studies looked at differences and diversity includes research that recognizes and celebrates difference.

Inter-coder reliability. The inter-rater reliability of the coding for articles' substantive matters was secured through four steps. First, all four researchers established a consensus for each category's definition in the Handbook of Physical Education (Kirk, et al., 2006) and the process for identifying the methodological approach. Second, three researchers analyzed twenty articles together to categorize and code them. When disagreement occurred, the three researchers went back to the mutually agreed upon guiding framework and further discussed the coding until 100% consensus was reached. Third, the three researchers independently coded another ten items and compared the results. When disagreement occurred, the researchers discussed until they reached 100% consensus. Three members of the research team then independently coded the rest of the articles, and they compared the results. The fourth researcher then reviewed the entire list for final verification. The four researchers were successful in establishing a 100% agreement for the data.

Bibliometric data analysis. To understand the impact of the top 100 most cited research articles in the field, descriptive statistics were applied to determine the total number of citations per item, average number of citations per year, and the total number of citations for the top 100 list over the last 30 years. The citation analysis then focused on research areas, specific authors, and journals.

3. Results

3.1 Overall Impacts of Physical Education Research in the Last 30 Years

In the top 100 list, 2005-2007 represented the most active years; during this time span, there were a total of 22 publications (see Figure 1). Overall, 59% of the articles on the top list were published between 1998-2007. Table 2 summarizes the top 100 articles, total citation numbers, and mean citation per year. Cumulatively, the sum of times cited for the top 100 list is 27,547. The sum of citations per year of the top 100 list has increased over time (see Figure 2). From 1990 – 2005, the sum of times cited per year was 2,891. Comparatively, from 2006 – 2015, there was a sum of 15,212 citations. In more recent years, 2016 and through 2020, the sum of citations has totaled 9,443. The top 100 list has an average of 18.04 citations per year ($SD = 13.32$; Range = 5.1-87.4). Authors from the top 100 list hailed from 25 different countries. The US had the most representation, accounting for 57% of the authorship. England came in second with 22%. Australia and Canada tallied 9% and 6%. The leading institutions for the top 100 list were San Diego State University (15 articles), University of Minnesota Twin Cities (9 articles), University of Texas System (8 articles), and outside of the US, the University of Birmingham (9 articles) was the leading institution.

Figure 1 Total Publications by Year in the Top 100 List

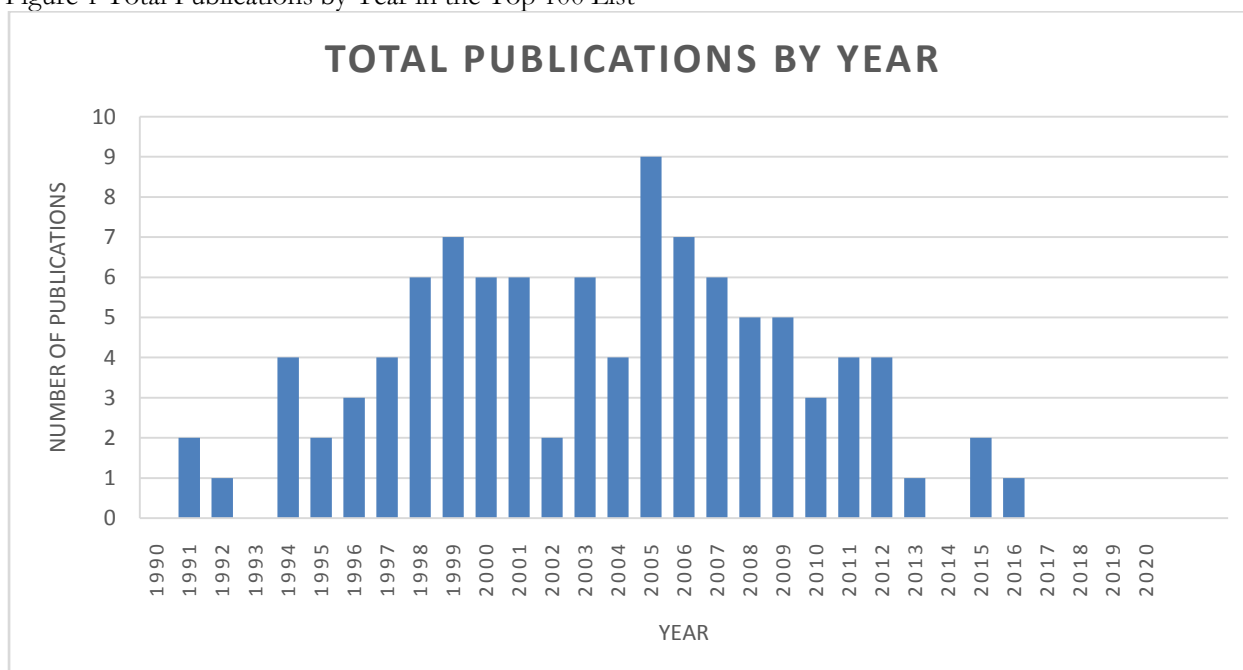
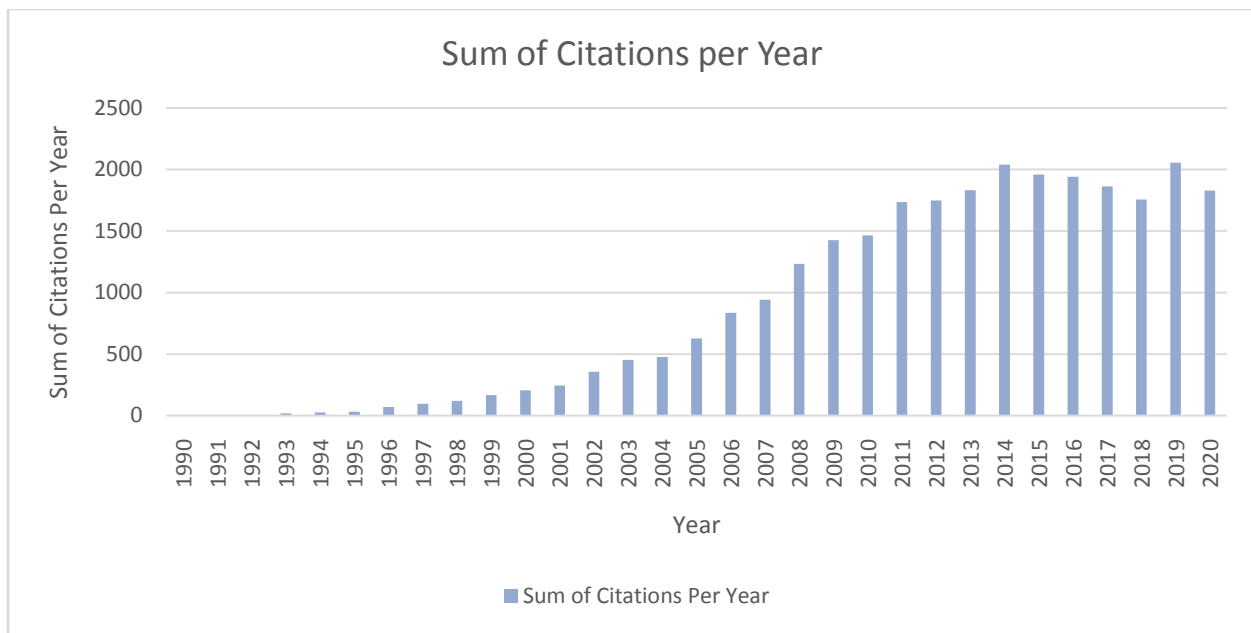


Figure 2. The Sum of Total Citations per Year in the Top 100 List



3.2 Impacts of Physical Education Research in Different Knowledge Areas

Table 3 illustrates the coded articles, total citations, average citations per item, and average citation per year information for each research area. A primary result was a prominence of cross-disciplinary research on the top 100 list representing over 80% of the articles. Topics such as PA, obesity prevention, motivation, and school-based interventions were well represented on the top 100 list. Psychology-based studies were also common to the cross-disciplinary category. Ntoumanis' (2001) article that explored self-determination theory in the physical education setting represents this focus.

Table 2 Top 100 Cited Articles that Involved Physical Education

Rank	Article	Times Cited	Mean Citations per Year
1	Kahn, E. B., Ramsey, L. T., Brownson, R. C., Heath, G. W., Howze, E. H., Powell, K. E., . . . Task Force Commun Prevent, S. (2002). The effectiveness of interventions to increase physical activity - A systematic review. <i>American Journal of Preventive Medicine</i> , 22(4), 73-108. doi:10.1016/s0749-3797(02)00434-8	1,275	67.11
2	Gortmaker, S. L., Peterson, K., Wiecha, J., Sobol, A. M., Dixit, S., Fox, M. K., & Laird, N. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth - Planet health. <i>Archives of Pediatrics & Adolescent Medicine</i> , 153(4), 409-418. doi:10.1001/archpedi.153.4.409	900	40.91
3	Van der Horst, K., Paw, M., Twisk, J. W. R., & Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. <i>Medicine and Science in Sports and Exercise</i> , 39(8), 1241-1250. doi:10.1249/mss.0b013e318059bf35	800	61.54
4	Luepker, R. V., Perry, C. L., McKinlay, S. M., Nader, P. R., Parcel, G. S., Stone, E. J., . . . Wu, M. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity - The Child and Adolescent Trial for Cardiovascular Health (CATCH). <i>JAMA-Journal of the American Medical Association</i> , 275(10), 768-776. doi:10.1001/jama.275.10.768	734	29.36
5	Baranowski, T., Anderson, C., & Carmack, C. (1998). Mediating variable framework in physical activity interventions - How are we doing? How might we do better? <i>American Journal of Preventive Medicine</i> , 15(4), 266-297. doi:10.1016/s0749-372222197(98)00080-4	637	27.70
6	van Sluijs, E. M. F., McMinn, A. M., & Griffin, S. (2007). Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. <i>BMJ-British Medical Journal</i> , 335(7622), 703-707. doi:10.1136/bmj.39320.843947.BE	613	47.15
7	Gordon-Larsen, P., McMurray, R. G., & Popkin, B. M. (2000). Determinants of adolescent physical activity and inactivity patterns. <i>Pediatrics</i> , 105(6). doi:10.1542/peds.105.6.e83	587	27.95
Rank	Article	Times	Mean

		Cited	Citations Per Year
8	Sallis, J. F., McKenzie, T. L., Alcaraz, J. E., Kolody, B., Faucette, N., & Hovell, M. F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. <i>American Journal of Public Health, 87</i> (8), 1328-1334. doi:10.2105/ajph.87.8.1328	563	23.46
9	Heath, G. W., Parra, D. C., Sarmiento, O. L., Andersen, L. B., Owen, N., Goenka, S., . . . Lancet Physical Activity Series Working Group. (2012). Evidence-based intervention in physical activity: Lessons from around the world. <i>Lancet, 380</i> (9838), 272-281. doi:10.1016/s0140-6736(12)60816-2	523	58.11
10	Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. <i>British Journal of Educational Psychology, 71</i> , 225-242. doi:10.1348/000709901158497	479	25.21
11	Standage, M., Duda, J. L., & Ntoumanis, N. (2005). A test of self-determination theory in school physical education. <i>British Journal of Educational Psychology, 75</i> , 411-433. doi:10.1348/000709904x22359	475	31.67
12	Standage, M., Duda, J. L., & Ntoumanis, N. (2003). A model of contextual motivation in physical education: Using constructs from self-determination and achievement goal theories to predict physical activity intentions. <i>Journal of Educational Psychology, 95</i> (1), 97-110. doi:10.1037/0022-0663.95.1.97	454	25.22
13	Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., . . . Szabo-Reed, A. N. (2016). Physical activity, fitness, cognitive function, and academic achievement in children: A Systematic Review. <i>Medicine and Science in Sports and Exercise, 48</i> (6), 1197-1222. doi:10.1249/mss.0000000000000901	437	87.4
14	Doak, C. M., Visscher, T. L. S., Renders, C. M., & Seidell, J. C. (2006). The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. <i>Obesity Reviews, 7</i> (1), 111-136. doi:10.1111/j.1467-789X.2006.00234.x	434	28.93
15	Slemenda, C. W., Miller, J. Z., Hui, S. L., Reister, T. K., & Johnston, C. C. (1991). Role of physical activity in the development of skeletal mass in children. <i>Journal of Bone and Mineral Research, 6</i> (11), 1227-1233.	395	13.62
16	Ntoumanis, N. (2005). A prospective study of participation in optional school physical education using a self-determination theory framework. <i>Journal of Educational Psychology, 97</i> (3), 444-453. doi:10.1037/0022-0663.97.3.444	388	25.87
17	Fuchs, R. K., Bauer, J. J., & Snow, C. M. (2001). Jumping improves hip and lumbar spine bone mass in prepubescent children: A randomized controlled trial. <i>Journal of Bone and Mineral Research, 16</i> (1), 148-156. doi:10.1359/jbmr.2001.16.1.148	357	17.85
18	Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. <i>International Journal of Behavioral Nutrition and Physical Activity, 5</i> . doi:10.1186/1479-5868-5-10	344	28.67
19	Sallis, J. F., McKenzie, T. L., Conway, T. L., Elder, J. P., Prochaska, J. J., Brown, M., . . . Alcaraz, J. E. (2003). Environmental interventions for eating and physical activity - A randomized controlled trial in middle schools. <i>American Journal of Preventive Medicine, 24</i> (3), 209-217. doi:10.1016/s0749-3797(02)00646-3	337	19.58
20	Goudas, M., Biddle, S., & Fox, K. (1994). Perceived locus of causality, goal orientations, and perceived competence in school physical-education classes. <i>British Journal of Educational Psychology, 64</i> , 453-463. doi:10.1111/j.2044-8279.1994.tb01116.x	333	12.81
21	Bradney, M., Pearce, G., Naughton, G., Sullivan, C., Bass, S., Beck, T., . . . Seeman, E. (1998). Moderate exercise during growth in prepubertal boys: Changes in bone mass, size, volumetric density, and bone strength: A controlled prospective study. <i>Journal of Bone and Mineral Research, 13</i> (12), 1814-1821. doi:10.1359/jbmr.1998.13.12.1814	331	14.39
22	Bailey, R. (2006). Physical education and sport in schools: A review of benefits and outcomes. <i>Journal of School Health, 76</i> (8), 397-401. doi:10.1111/j.1746-1561.2006.00132.x	317	22.64
23	Hagger, M. S., Chatzisarantis, N. L. D., Culverhouse, T., & Biddle, S. J. H. (2003). The processes by which perceived autonomy support in physical education promotes leisure-time physical activity intentions and behavior: A trans-contextual model. <i>Journal of Educational Psychology, 95</i> (4), 784-795. doi:10.1037/0022-0663.95.4.784	315	18.53
24	Coe, D. P., Pivarnik, J. M., Womack, C. J., & Reeves, M. J. (2006). Effect of physical education and activity levels on academic achievement in children. <i>Medicine and Science in Sports and Exercise, 38</i> (8), 1515-1519. doi:10.1249/01.mss.0000227537.13175.1b	310	22.14
25	Motl, R. W., Dishman, R. K., Saunders, R., Dowda, M., Felton, G., & Pate, R. R. (2001). Measuring enjoyment of physical activity in adolescent girls. <i>American Journal of Preventive Medicine, 21</i> (2), 110-117. doi:10.1016/s0749-3797(01)00326-9	301	15.05
26	Sallis, J. F., McKenzie, T. L., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. <i>Research Quarterly for Exercise and Sport, 70</i> (2), 127-134. doi:10.1080/02701367.1999.10608030	298	13.55
27	Stone, E. J., McKenzie, T. L., Welk, G. J., & Booth, M. L. (1998). Effects of physical activity interventions in youth - Review and synthesis. <i>American Journal of Preventive Medicine, 15</i> (4), 298-315. doi:10.1016/s0749-3797(98)00082-8	296	12.87
28	Telama, R., Yang, X. L., Laakso, L., & Viikari, J. (1997). Physical activity in childhood and adolescence as predictor of physical activity in young adulthood. <i>American Journal of Preventive Medicine, 13</i> (4), 317-323.	283	12.86
29	Lee, S. M., Burgeson, C. R., Fulton, J. E., & Spain, C. G. (2007). Physical education and physical activity: Results from the school health policies and programs study 2006. <i>Journal of School Health, 77</i> (8), 435-463. doi:10.1111/j.1746-1561.2007.00229.x	283	21.77
Rank	Article	Times Cited	Mean Citations

			Per Year
30	Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. <i>Preventive Medicine, 52</i> , S10-S20. doi:10.1016/j.ypmed.2011.01.027	278	27.8
31	Ruiz, J. R., Zahner, L., & Schindler, C. (2011). Field-based fitness assessment in young people: The ALPHA health-related fitness test batter for children and adolescents. <i>British Journal of Sports Medicine, 45</i> (6), 518-524.	276	27.6
32	Kriemler, S., Zahner, L., Schindler, C., Meyer, U., Hartmann, T., Hebestreit, H., . . . Puder, J. J. (2010). Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: Cluster randomised controlled trial. <i>BMJ-British Medical Journal, 340</i> . doi:10.1136/bmj.c785	275	25
33	Sallis, J. F., Prochaska, J. J., Taylor, W. C., Hill, J. O., & Geraci, J. C. (1999). Correlates of physical activity in a national sample of girls and boys in Grades 4 through 12. <i>Health Psychology, 18</i> (4), 410-415. doi:10.1037/0278-6133.18.4.410	271	12.9
34	McCambridge, T. M., Bernhardt, D. T., Brenner, J. S., Congeni, J. A., Gomez, J. E., Gregory, A. J., ... & Small, E. W. (2006). Active healthy living: prevention of childhood obesity through increased physical activity. <i>Pediatrics, 117</i> (5), 1834-1842.	269	17.93
35	Ntoumanis, N., & Biddle, S. J. (1999). A review of motivational climate in physical activity. <i>Journal of Sports Sciences, 17</i> (8), 643-665.	261	11.86
36	Sallis, J. F., Zakarian, J. M., Hovell, M. F., & Hofstetter, C. R. (1996). Ethnic, socioeconomic, and sex differences in physical activity among adolescents. <i>Journal of Clinical Epidemiology, 49</i> (2), 125-134.	259	10.79
37	Papastergiou, M. (2009). Exploring the potential of computer and video games for health and physical education: A literature review. <i>Computers & Education, 53</i> (3), 603-622.	256	23.27
38	Dollman, J., Norton, K., & Norton, L. (2005). Evidence for secular trends in children's physical activity behaviour. <i>British Journal of Sports Medicine, 39</i> (12), 892-897. doi:10.1136/bjism.2004.016675	247	16.47
39	Salmon, J., Booth, M. L., Phongsavan, P., Murphy, N., & Timperio, A. (2007). Promoting physical activity participation among children and adolescents. <i>Epidemiologic Reviews, 29</i> , 144-159. doi:10.1093/epirev/mxm010	238	17
40	Nader, P. R., Stone, E. J., Lytle, L. A., Perry, C. L., Osganian, S. K., Kelder, S., Webber, L.S., Elder, J.P., Montgomery, D., Feldman, H.A., Wu, M., Johnson, C., Parce, G.S., & Luepker, R. V. (1999). Three-year maintenance of improved diet and physical activity - The CATCH cohort. <i>Archives of Pediatrics & Adolescent Medicine, 153</i> (7), 695-704. doi:10.1001/archpedi.153.7.695	237	10.82
41	Bailey, R., Armour, K., Kirk, D., Jess, M., Pickup, I., Sandford, R., & Education, B.P. (2009). The educational benefits claimed for physical education and school sport: an academic review. <i>Research Papers in Education, 24</i> (1), 1-27. doi:10.1080/02671520701809817	232	21.1
42	Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H., & Lee, S. (2012). Physical education's role in public health: Steps forward and backward over 20 years and HOPE for the future. <i>Research Quarterly for Exercise and Sport, 83</i> (2), 125-135. doi:10.1080/02701367.2012.10599842	231	25.67
43	Standage, M., Duda, J. L., & Ntoumanis, N. (2006). Students' motivational processes and their relationship to teacher ratings in school physical education: A self-determination theory approach. <i>Research Quarterly for Exercise and Sport, 77</i> (1), 100-110. doi:10.5641/027013606x13080769704046	230	16.43
44	Neumark-Sztainer, D., Story, M., Hannan, P. J., & Rex, J. (2003). New Moves: A school-based obesity prevention program for adolescent girls. <i>Preventive Medicine, 37</i> (1), 41-51. doi:10.1016/s0091-7435(03)00057-4	227	12.61
45	Webber, L. S., Catellier, D. J., Lytle, L. A., Murray, D. M., Pratt, C. A., Young, D. R., . . . Pate, R. R. (2008). Promoting physical activity in middle school girls - Trial of activity for adolescent girls. <i>American Journal of Preventive Medicine, 34</i> (3), 173-184. doi:10.1016/j.amepre.2007.11.018	225	17.31
46	McKay, H. A., Petit, M. A., Schutz, R. W., Prior, J. C., Barr, S. I., & Khan, K. M. (2000). Augmented trochanteric bone mineral density after modified physical education classes: A randomized school-based exercise intervention study in prepubescent and early pubescent children. <i>Journal of Pediatrics, 136</i> (2), 156-162. doi:10.1016/s0022-3476(00)70095-3	219	10.43
47	McKenzie, T. L., Sallis, J. F., & Nader, P. R. (1992). SOFIT - System for observing fitness instruction time. <i>Journal of Teaching in Physical Education, 11</i> (2), 195-205. doi:10.1123/jtpe.11.2.195	219	8.38
48	Haerens, L., Aelterman, N., Vansteenkiste, M., Soenens, B., & Van Petegem, S. (2015). Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation. <i>Psychology of Sport and Exercise, 16</i> , 26-36. doi:10.1016/j.psychsport.2014.08.013	216	36
49	McKenzie, T. L., Nader, P. R., Strikmiller, P. K., Yang, M., Stone, E. J., Perry, C. L., Taylor, W.C., Epping, J.N., Feldman, H.A., Luepker, S.H., & Kelder, S. H. (1996). School physical education: Effect of the Child and Adolescent Trial for Cardiovascular Health. <i>Preventive Medicine, 25</i> (4), 423-431.	212	8.48
50	Trost, S. G., Pate, R. R., Saunders, R., Ward, D. S., Dowda, M., & Felton, G. (1997). A prospective study of the determinants of physical activity in rural fifth-grade children. <i>Preventive Medicine, 26</i> (2), 257-263. doi:10.1006/pmed.1996.0137	211	9.17

Rank	Article	Times Cited	Mean Citations
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			Per Year
51	Chomitz, V. R., Slining, M. M., McGowan, R. J., Mitchell, S. E., Dawson, G. F., & Hacker, K. A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the Northeastern United States. <i>Journal of School Health, 79</i> (1), 30-36. doi:10.1111/j.1746-1561.2008.00371.x	209	17.42
52	Veugelers, P. J., & Fitzgerald, A. L. (2005). Prevalence of and risk factors for childhood overweight and obesity. <i>Canadian Medical Association Journal, 173</i> (6), 607-613. doi:10.1503/cmaj.050445	207	13.8
53	Dishman, R. K., Motl, R. W., Saunders, R., Felton, G., Ward, D. S., Dowda, M., & Pate, R. R. (2004). Self-efficacy partially mediates the effect of a school-based physical-activity intervention among adolescent girls. <i>Preventive Medicine, 38</i> (5), 628-636. doi:10.1016/j.ypmed.2003.12.007	207	12.18
54	Sahota, P., Rudolf, M. C. J., Dixey, R., Hill, A. J., Barth, J. H., & Cade, J. (2001). Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. <i>BMJ-British Medical Journal, 323</i> (7320), 1029-1032. doi:10.1136/bmj.323.7320.1029	205	10.25
55	Tudor-Locke, C., Lee, S. M., Morgan, C. F., Beighle, A., & Pangrazi, R. P. (2006). Children's pedometer-determined physical activity during the segmented school day. <i>Medicine and Science in Sports and Exercise, 38</i> (10), 1732-1738. doi:10.1249/01.mss.0000230212.55119.98	204	14.57
56	Flintoff, A., & Scraton, S. (2001). Stepping into active leisure? Young women's perceptions of active lifestyles and their experiences of school physical education. <i>Sport Education and Society, 6</i> (1), 5-21. doi:10.1080/713696043	203	10.63
57	Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. <i>Preventative Medicine, 56</i> (2), 152-161. doi: 10.1016/j.ypmed.2012.12.004.	200	25
58	MacKelvie, K. J., McKay, H. A., Khan, K. M., & Crocker, P. R. E. (2001). A school-based exercise intervention augments bone mineral accrual in early pubertal girls. <i>Journal of Pediatrics, 139</i> (4), 501-508. doi:10.1067/mpd.2001.118190	196	10.32
59	Carrel, A. L., Clark, R. R., Peterson, S. E., Nemeth, B. A., Sullivan, J., & Allen, D. B. (2005). Improvement of fitness, body composition, and insulin sensitivity in overweight children in a school-based exercise program - A randomized, controlled study. <i>Archives of Pediatrics & Adolescent Medicine, 159</i> (10), 963-968. doi:10.1001/archpedi.159.10.963	191	11.88
60	Carlson, T. B. (1995). We hate gym - Student alienation from physical education. <i>Journal of Teaching in Physical Education, 14</i> (4), 467-477. doi:10.1123/jtpe.14.4.467	191	7.64
61	Ferrer-Caja, E., & Weiss, M. R. (2000). Predictors of intrinsic motivation among adolescent students in physical education. <i>Research Quarterly for Exercise and Sport, 71</i> (3), 267-279. doi:10.1080/02701367.2000.10608907	189	9.45
62	Story, M. (1999). School-based approaches for preventing and treating obesity. <i>International Journal of Obesity, 23</i> , S43-S51. doi:10.1038/sj/ijo/0800859	188	8.55
63	Ennis, C. D. (1999). Creating a culturally relevant curriculum for disengaged girls. <i>Sport Education and Society, 4</i> (1), 31-49. doi:10.1080/1357332990040103	186	8.45
64	Sharma, M. (2006). School-based interventions for childhood and adolescent obesity. <i>Obesity Reviews, 7</i> (3), 261-269. doi:10.1111/j.1467-789X.2006.00227.x	185	13.21
65	Tessier, D., Sarrazin, P., & Ntoumanis, N. (2010). The effect of an intervention to improve newly qualified teachers' interpersonal style, students motivation and psychological need satisfaction in sport-based physical education. <i>Contemporary Educational Psychology, 35</i> (4), 242-253.	184	16.73
66	Knuth, A. G., & Hallel, P. C. (2009). Temporal trends in physical activity: A systematic review. <i>Journal of Physical Activity & Health, 6</i> (5), 548-559. doi:10.1123/jpah.6.5.548	184	16.73
67	Staiano, A. E., & Calvert, S. L. (2011). Exergames for Physical Education Courses: Physical, Social, and Cognitive Benefits. <i>Child Development Perspectives, 5</i> (2), 93-98. doi:10.1111/j.1750-8606.2011.00162.x	182	18.2
68	Hills, A. P., Dengel, D. R., & Lubans, D. R. (2015). Supporting public health priorities: Recommendations for physical education and physical activity promotion in schools. <i>Progress in Cardiovascular Diseases, 57</i> (4), 368-374. doi:10.1016/j.pcad.2014.09.010	182	30.33
69	McKenzie, T. L., Sallis, J. F., Prochaska, J. J., Conway, T. L., Marshall, S. J., & Rosengard, P. (2004). Evaluation of a two-year middle-school physical education intervention: M-SPAN. <i>Medicine and Science in Sports and Exercise, 36</i> (8), 1382-1388. doi:10.1249/01.mss.0000135792.20358.4d	181	11.31
70	McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Student activity levels, lesson context, and teacher behavior during middle school physical education. <i>Research Quarterly for Exercise and Sport, 71</i> (3), 249-259. doi:10.1080/02701367.2000.10608905	178	8.9
71	Taylor, I. M., & Ntoumanis, N. (2007). Teacher motivational strategies and student self-determination in physical education. <i>Journal of Educational Psychology, 99</i> (4), 747-760. doi:10.1037/0022-0663.99.4.747	176	13.54
72	Oslin, J. L., Mitchell, S. A., & Griffin, L. L. (1998). The Game Performance Assessment Instrument (GPAI): Development and preliminary validation. <i>Journal of Teaching in Physical Education, 17</i> (2), 231-243. doi:10.1123/jtpe.17.2.231	176	7.65
73	Kirk, D., & MacPhail, A. (2002). Teaching games for understanding and situated learning: Rethinking the Bunker-Thorp model. <i>Journal of Teaching in Physical Education, 21</i> (2), 177-192. doi:10.1123/jtpe.21.2.177	173	9.61
74	Bailey, R. (2005). Evaluating the relationship between physical education, sport and social inclusion. <i>Educational Review, 57</i> (1), 71-90. doi:10.1080/0013191042000274196	172	11.47
Rank	Article	Times Cited	Mean Citations Per Year

75	Cheon, S. H., Reeve, J., & Moon, I. S. (2012). Experimentally based, longitudinally designed, teacher-focused intervention to help physical education teachers be more autonomy supportive toward their students. <i>Journal of Sport & Exercise Psychology</i> , 34(3), 365-396. doi:10.1123/jsep.34.3.365	171	19
76	Standage, M., Gillison, F. B., Ntoumanis, N., & Treasure, D. C. (2012). Predicting students' physical activity and health-related well-being: A prospective Cross-domain investigation of motivation across school physical education and exercise settings. <i>Journal of Sport & Exercise Psychology</i> , 34(1), 37-60. doi:10.1123/jsep.34.1.37	170	19
77	Dale, D., Corbin, C. B., & Dale, K. S. (2000). Restricting opportunities to be active during school time: Do children compensate by increasing physical activity levels after school? <i>Research Quarterly for Exercise and Sport</i> , 71(3), 240-248. doi:10.1080/02701367.2000.10608904	170	8.5
78	Carlson, S. A., Fulton, J. E., Lee, S. M., Maynard, M., Brown, D. R., Kohl, H. W., & Dietz, W. H. (2008). Physical education and academic achievement in elementary school: Data from the early childhood longitudinal study. <i>American Journal of Public Health</i> , 98(4), 721-727. doi:10.2105/ajph.2007.117176	169	14.1
79	Matson-Koffman, D. M., Brownstein, J. N., Neiner, J. A., & Greaney, M. L. (2005). A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: What works? <i>American Journal of Health Promotion</i> , 19(3), 167-193. doi:10.4278/0890-1171-19.3.167	168	10.5
80	Zakarian, J. M., Hovell, M. F., Hofstetter, C. R., Sallis, J. F., & Keating, K. J. (1994). Correlates of vigorous exercise in a predominately low SES and minority high-school population. <i>Preventive Medicine</i> , 23(3), 314-321. doi:10.1006/pmed.1994.1044	168	6.46
81	Neumark-Sztainer, D., Story, M., Hannan, P. J., Tharp, T., & Rex, J. (2003). Factors associated with changes in physical activity - A cohort study of inactive adolescent girls. <i>Archives of Pediatrics & Adolescent Medicine</i> , 157(8), 803-810. doi:10.1001/archpedi.157.8.803	166	10.38
82	Kirk, D., & Macdonald, D. (1998). Situated learning in physical education. <i>Journal of Teaching in Physical Education</i> , 17(3), 376-387. doi:10.1123/jtpe.17.3.376	163	7.41
83	Vilhjalmsson, R., & Kristjansdottir, G. (2003). Gender differences in physical activity in older children and adolescents: the central role of organized sport. <i>Social Science & Medicine</i> , 56(2), 363-374. doi:10.1016/s0277-9536(02)00042-4	163	9.06
84	Coleman, K. J., Tiller, C. L., Sanchez, J., Heath, E. M., Sy, O., Milliken, G., & Dziewaltowski, D. A. (2005). Prevention of the epidemic increase in child risk of overweight in low-income schools - The El Paso coordinated approach to child health. <i>Archives of Pediatrics & Adolescent Medicine</i> , 159(3), 217-224. doi:10.1001/archpedi.159.3.217	162	10.8
85	Lakes, K. D., & Hoyt, W. I. (2004). Promoting self-regulation through school-based martial arts training. <i>Journal of Applied Developmental Psychology</i> , 25(3), 283-302. doi:10.1016/j.appdev.2004.04.002	161	9.47
86	Papaioannou, A. (1994). Development of a questionnaire to measure achievement orientations in physical education. <i>Research Quarterly for Exercise and Sport</i> , 65(1), 11-20. doi:10.1080/02701367.1994.10762203	160	5.93
87	Bauer, K. W., Yang, Y. W., & Austin, S. B. (2004). "How can we stay healthy when you're throwing all of this in front of us?" - Findings from focus groups and interviews in middle schools on environmental influences on nutrition and physical activity. <i>Health Education & Behavior</i> , 31(1), 34-46. doi:10.1177/1090198103255372	159	9.94
88	Hagger, M. S., Chatzisarantis, N. L. D., Barkoukis, V., Wang, C. K. J., & Baranowski, J. (2005). Perceived autonomy support in physical education and leisure-time physical activity: A Cross-cultural evaluation of the trans-contextual model. <i>Journal of Educational Psychology</i> , 97(3), 376-390. doi:10.1037/0022-0663.97.3.376	158	10.53
89	Taylor, I. M., Ntoumanis, N., Standage, M., & Spray, C. M. (2010). Motivational predictors of physical education students' effort, exercise intentions, and leisure-time physical activity: A multilevel linear growth analysis. <i>Journal of Sport & Exercise Psychology</i> , 32(1), 99-120. doi:10.1123/jsep.32.1.99	157	14.27
90	Wickel, E. E., & Eisenmann, J. C. (2007). Contribution of youth sport to total daily physical activity among 6-to 12-year-old boys. <i>Medicine and Science in Sports and Exercise</i> , 39(9), 1493-1500. doi:10.1249/mss.0b013e318093f56a	153	11.77
91	McKenzie, T. L., Feldman, H., Woods, S. E., Romero, K. A., Dahlstrom, V., Stone, E. J., Strikmiller, P.K., Williston, J.M., & Harsha, D. W. (1995). Children activity levels and lesson context during 3rd-grade physical education. <i>Research Quarterly for Exercise and Sport</i> , 66(3), 184-193. doi:10.1080/02701367.1995.10608832	153	6.12
92	Smith, E., Kirchner, H. L., Taylor, M., Hoffman, H., & Lemke, J. H. (1998). Voice problems among teachers: Differences by gender and teaching characteristics. <i>Journal of Voice</i> , 12(3), 328-334. doi:10.1016/s0892-1997(98)80022-2	152	7.24
93	Tompsonowski, P. D., Lambourne, K., & Okumura, M. S. (2011). Physical activity interventions and children's mental function: An introduction and overview. <i>Preventive Medicine</i> , 52, S3-S9. doi:10.1016/j.ympmed.2011.01.028	151	15.1
94	Hagger, M., Chatzisarantis, N. L. D., Hein, V., Soos, I., Karsai, I., Lintunen, T., & Leemans, S. (2009). Teacher, peer and parent autonomy support in physical education and leisure-time physical activity: A trans-contextual model of motivation in four nations. <i>Psychology & Health</i> , 24(6), 689-711. doi:10.1080/08870440801956192	151	13.73
95	Goodwin, D. L., & Watkinson, E. J. (2000). Inclusive physical education from the perspective of students with physical disabilities. <i>Adapted Physical Activity Quarterly</i> , 17(2), 144-160. doi:10.1123/apaq.17.2.144	150	7.14
96	Shephard, R. J. (1997). Curricular physical activity and academic performance. <i>Pediatric Exercise Science</i> , 9(2), 113-126. doi:10.1123/pes.9.2.113	149	6.48
Rank	Article	Times Cited	Mean Citations Per Year

97	Simonsmorton, B. G., Parcel, G. S., Baranowski, T., Forthofer, R., & Ohara, N. M. (1991). Promoting physical activity and a healthful diet among children – Results of a school-based intervention study. <i>American Journal of Public Health</i> , 81(8), 986-991. doi:10.2105/ajph.81.8.986	148	5.1
98	Mouratidis, A., Vansteenkiste, M., Lens, W., & Sideridis, G. (2008). The motivating role of positive feedback in sport and physical education: Evidence for a motivational model. <i>Journal of Sport & Exercise Psychology</i> , 30(2), 240-268. doi:10.1123/jsep.30.2.240	147	11.31
99	Cox, A., & Williams, L. (2008). The roles of perceived teacher support, motivational climate, and psychological need satisfaction in students' physical education motivation. <i>Journal of Sport & Exercise Psychology</i> , 30(2), 222-239. doi:10.1123/jsep.30.2.222	146	11.23
100	Heath, G. W., Pratt, M., Warren, C. W., & Kann, L. (1994). Physical-activity patterns in American high school students - Results from the 1990 youth risk behavior survey. <i>Archives of Pediatrics & Adolescent Medicine</i> , 148(11), 1131-1136. doi:10.1001/archpedi.1994.02170110017003	145	5.58

Figure 3 shows the chronological summary of the number of publications for the top 100 list for each research area. While the cross-disciplinary has a significant presence in the top 100 list, the number of publications in this category has been a constant over time. Citation totals further elucidate this finding. In total, the cross-disciplinary articles have accumulated 25,514 citations. While the numbers are not exceptionally high, the three research areas, learners and learning, physical education curriculum, and teachers, teaching, and teacher education, have a consistent number of publications across 30 years. Relative to differences and diversity, the notable trend of increasing publication can be seen from 1990 to 2010. See Table 3 for a depiction of how the bibliometric data varied across the physical education research areas.

Table 3 Summary of Influential Research Across Categories from 1990-2020

Category	Articles*	Total Citations	Average Citations per Item	Average Citations per Year
Cross-Disciplinary	1-36, 38-40, 42-59, 61, 62, 64-66, 68-71, 75-81, 83-91, 93, 94, 96-100	25,514	287	18.83
Learners and Learning	8, 22, 36, 43, 47, 60, 70, 72, 74, 76, 88, 91, 94, 95, 99	3,233	215.53	12.3
Theoretical Perspectives	82	163	7.41	7.41
Teachers, Teaching, & Teacher Education	31, 47, 48, 65, 70, 71, 75, 92	1,572	196.5	17.17
Physical Education Curriculum	8, 26, 37, 41, 47, 63, 67, 69, 70, 73	2,468	246.8	14.62
Differences and Diversity	25, 36, 45, 53, 56, 63, 83, 88, 94, 95	2,003	200.3	11.44

Note. * = The number illustrates the rank of the article identified in Table 2. Some items have multiple codes.

3.4 Top Active Authors and Journal Outlets

Among this list, three researchers had at least five articles on the top 100 list. McKenzie was a lead author on five articles and a contributing author on another five articles. His article in 1997 that focused on a school-based intervention to examine the effect of SPARK on elementary school students has generated the most citations (Sallis et al., 1997). McKenzie's publications have tabulated a total of 2,668 citations, which represents 9.68% of the cumulative citations of the 100 lists. Sallis' contributions to the top 100 list totaled ten publications. He has accumulated six first author articles and four articles as a contributor. Like McKenzie, Sallis' work focused extensively on the promotion of PA. His publications have collected 2,705 citations (9.82% of the cumulative citations of the top 100 articles). The next notable contributor to the top 100 list is Ntoumanis. All total,

Ntoumanis has three first-author publications and served as a contributing author on seven articles. Motivation and self-determination theory served as the primary areas of emphasis within his research line. Ntoumanis' publications have collected 2,974 citations (10.79% of the cumulative citations of the top 100 articles). In total, the three most active authors account for 8,347 citations (30.3% of the cumulative citations of the top 100 articles).

The articles on the top 100 list were disseminated across various journals in terms of distribution outlets. As illustrated in Table 4, eight journals are credited with at least five articles on the list. Research Quarterly for Exercise and Sport accounted for eight articles. The American Journal of Preventive Medicine and Preventive Medicine are each credited with six articles. In total, the journals with five or more articles have generated 13,507 citations, which accounts for 49.03% of the total citations for the top 100 list.

Table 4 | Journals with 5 or more Publications on the Top 100 List

Journal	Articles	Sum of Times Cited	Mean Citations per Article	Impact Factor (Year)
Research Quarterly for Exercise and Sport	8	1,609	201.13	1.883 (2019)
American Journal of Preventive Medicine	7	3,354	479.14	4.420 (2019)
Preventive Medicine	7	1,454	207.71	3.788 (2020)
Archives of Pediatrics & Adolescent Medicine	6	1,801	300.17	5.731 (2020)
Medicine and Science in Sports and Exercise	6	2,085	347.5	4.478 (2020)
Journal of Educational Psychology	5	1,491	298.2	5.028 (2020)
Journal of Sport & Exercise Psychology	5	791	158.2	2.239 (2020)
Journal of Teaching in Physical Education	5	922	184.4	1.845 (2020)

3.5 Methodological Trends

Overall, the most common methodological approach on the top 100 list was that of a review paper. Kahn and colleagues' (2002) systematic review paper on PA interventions is the most cited from this methodological approach. Survey research was the next most common methodological approach. For example, Gordon-Larsen and colleagues' (2000) article explored the determinants of PA in adolescents. Different quantitative research studies were in the next group. Among the quantitative studies, randomized, controlled field trials, was the next most frequently used methodological approach. Gortmaker and colleagues' (1999) research article examined the impact of a school-based intervention to reduce obesity among youth.

Table 5 presents primary (i.e., more than two articles used the design) types of methodological approaches used in the articles and the relation to the different physical education research areas, research topics, and presence on the Top 100 list. The research approaches used in the most cited articles were different in each physical education research area. Cross-disciplinary and physical education curriculum research was mainly conducted using the quantitative research design, while the differences and diversity research area adopted qualitative approaches. The articles in two other areas, learners and learning, teachers, teaching, and teacher education, represented qualitative and quantitative research designs.

Table 5. Research Knowledge Areas and Methodological Trends of the Top 100 List

Handbook of PE Category	Primary Study Design(s)	Primary Topics	Number of Articles Top 100 List
Cross-disciplinary	Review Survey Randomized, Controlled Field Trial Cohort Study	Physical activity Obesity Prevention Academic achievement Motivation	89 articles
Learners and learning	Review Qualitative Survey Observational	Benefits of physical education Physical activity Student perception of physical education	15 articles
Physical education curriculum	Survey Review Quasi-Experimental	SPARK TGfU	10 articles
Differences and diversity	Qualitative Survey	Gender differences	9 articles
Teachers, teaching, and teacher education	Observational Review Qualitative Survey	Teacher behaviors Assessment	8 articles
Theoretical perspectives	Review	Situated Learning	1 article

4. Discussion

The purpose of this research was to conduct a bibliometric analysis of research output within the physical education knowledge base over the last 30 years. Physical education's knowledge base has expanded over time. Within this macro-level analysis, there was attention directed to scholars within and outside the field who have disseminated research articles involving physical education. Importantly, the bibliometric approach has yielded a general overview of scholarly research outputs involving physical education between 1990 – 2020.

The top 100 cited articles that involved physical education from the WoS database indicated a knowledge base that has grown over time. In line with other scholars' findings, this bibliometric analysis further supports the notion that the physical education knowledge base is growing (Martinen, et al., 2017). A featured contribution this paper provides is a 30,000-foot view of the knowledge base. It is from this macro-level view that clear trends emerged. Of note, just under 90% of the articles were characterized as cross-disciplinary. A singular point of interest was the presence of public health-oriented research articles. Public health scholars have disseminated research articles that have explored the issue of school-based physical education as a means to promote PA (McKenzie, et al., 1996); school-based physical education as part of a multicomponent intervention to promote PA and/or improved nutrition (Gortmaker, et al., 1999); conducted several reviews to provide current understanding on effective interventions to improve the health of youth (Kahn, et al., 2002); and studies that have explored the relationship between PA and cognitive function (Donnelly, et al., 2016).

The volume of publications and citations suggest that this line of research has attracted a great deal of interest from within and outside the field of physical education. Another conclusion that can be drawn concerning interest in public health is that of longevity.

From the early 1990s through 2016, researchers have explored issues that would fall under the public health realm. As articulated by two of the most active scholars on the top 100 list, Sallis and McKenzie (1991) stressed the need to re-shape school-based physical education to align with public health-related outcomes. The bibliometric data from this study indicates that these calls for attention have been met.

Interestingly, this study's notable finding is that this call to action has been met by scholars from various backgrounds and fields of study. The range of journals from the top 100 list documents how research studies that involved school-based physical education have been published in medical, public health, and discipline-specific outlets. Interdisciplinary attention directed toward school-based physical education speaks to the contextual relevance that this setting holds for scholars from different disciplines. It could also be gleaned that physical education's contextual relevance can be leveraged by those within the field for continued partnerships with scholars from public health and medical backgrounds.

Beyond public health, psychology is a field that has found a hold in the physical education knowledge base. In particular, motivation and surrounding issues have received a great deal of attention. The two leading scholars, Ntoumanis and Standage, have disseminated several well-cited papers on motivation in the physical education setting. A salient takeaway from this research line is the relevance of self-determination theory and how it is a guiding theoretical construct underpinning motivation-oriented studies. Researchers from this line of inquiry have also directed attention toward how teachers' behaviors influence student motivation (Standage, et al., 2006); influences on students' participation in physical education (Ntoumanis, et al., 2005); and how motivation can predict students' intention to be physically active (Taylor, et al., 2010). Like public health, motivation has been a long-standing line of inquiry within the physical education knowledge base. Researchers from this area of emphasis have contributed several important findings to enhance our understanding of motivation and the importance of students' motivation toward physical education and PA.

Diversity and representation were common to the top 100 list. While most scholars resided in the US and England, overall authorship on the top 100 list represented over 20 different countries. When examining the issue of geographic location, there is compelling evidence suggesting that the topic of physical education has garnered interest from around the world. It is also an issue that warrants further examination concerning who is disseminating research on physical education around the world and what topics they are exploring. One prominent example from this study is that the leading motivation researchers, Ntoumanis and Standage, at the time of publication resided in Europe. A broader implication of this finding is that of an increased opportunity for scholars to collaborate on research initiatives from a multicultural perspective, such as Hagger and colleagues' (2013) study that explored adolescent motivation for PA from a global perspective.

Another principal finding was found in the diversification of approaches to methodologies. Within those approaches, it is interesting to note that topics could also be equated to methodology approaches. It was more likely for public health to see methodological approaches that included quantitative centered designs such as experimental, intervention, cross-section, and systematic reviews. In comparison, motivation researchers seemed to gravitate toward a survey methodology. More broadly, there was a range of methodologies applied to articles on the top 100 list. Consequently, this bibliometric analysis's novel contribution is the presence of highly cited research articles that contain an array of different research methodologies that can be considered for future studies that examine topics pertinent to physical education.

Issues that cross disciplinary lines, such as public health and psychology, have gained traction from a consumption perspective. The sheer volume of citations that these issues have generated serves as solid evidence to support this assertion. When approaching cross-disciplinary research, it can also be inferred that it opens up research to a broader audience, for issues closer to physical education, the bibliometric analysis produced insight into prominent topics. For example, curriculum is one topic that has been investigated. McKenzie's work with SPARK is one notable example. Teaching Games for Understanding is another curricular approach that has received interest (Kirk & MacPhail, 2002). Beyond curriculum, the top 100 list also included studies that explored the issue of diversity and differences. Ennis' (1999) article is a shining example of this category. In the article, Ennis captured the lived experiences and perceptions of female students toward school-based physical education. Flintoff and Scranton's (2001) article examined adolescent females' experiences in physical education. These examples showcase topics and authors who are leading voices on issues very close to physical education.

Moreover, these are publications and authors whose work should be widely promoted for consumption because of insights on highly relevant issues to the work of physical educators.

Future Directions

We propose four major future directions. First, this study showed that while physical education is seen as a marginalized subject area, scholarly attention has been paid not only inside the field but also outside of the field. It is important to continue collaborating with researchers from different fields to enhance the field's standing further. Second, the articles in the top 100 list represented various research designs; thus, indicating the importance of applying different, rigorous methodologies to acquire comprehensive views of a topic. However, we think it is important to emphasize the importance of experimental studies. Siedentop (1982) claimed, "if you want to really understand something, try to change it" (p. 48). McKenzie is an exemplar of this mentality. His work provides a template wherein a scholar can define the problem, develop an intervention, establish a rigorous study design, and document the impact. Third, as many review articles were present in the top 100 list, this type of research article has tremendous value to understand a knowledge area. As discussed at the beginning of the article, reviews enable scholars to synthesize knowledge, provide an overview of the current state of knowledge, highlight gaps, and pinpoint future directions (Hulland & Houston, 2020). Consistent efforts of producing quality reviews will lead to the production of meaningful and valuable research in the future. Physical education is an evidence-based practice (Rink, 2014). Continuous collective efforts of scholars in the field of physical education are warranted. Fourth, the top 100 list indicates a clear response to calls for action that were sounding for issues related to physical inactivity, childhood obesity, and related matters. The galvanizing effort by scholars in and outside of physical education is admirable. Importantly, the focus on public health matters shows the impact that focused, collaborative research efforts can produce. We view this as a beacon of hope for emerging societal topics, such as social justice. The field of physical education has a documented track record of answering calls to action. Moving forward, it will be important to continue to examine how research trends evolve.

Limitations

A primary limitation of this study is that the citations were strictly drawn from the WoS database. Other inquiries could be made through different platforms, such as Google Scholar, that may produce different results regarding bibliometric data. Another limitation relates to citations and how such factors as favorability toward an institution, language, and self-citation can all influence data. Another limitation for bibliometric data is the date of publication. Recent publications are typically not going to accumulate the number of citations as older publications. For this particular issue, citations per year can help mitigate the issue of publication date.

5. Conclusion

The top 100 list derived from this bibliometric analysis provides a broad perspective on the physical education knowledge base. The study results revealed interesting insights into the physical education knowledge base and hold a degree of material relevance for those seeking information within the field. Prominent topics, influential authors, and journal outlets for publication can be discerned within the study results. The assumption of a broad analysis also showcased the contextual relevance of school-based physical education to scholars from different fields of study.

Physical education is an academic subject that crosses disciplinary lines. Motor learning, motor development, exercise physiology, public health, and pedagogy are just some of the fields that intersect within the physical education setting. The top 100 list is populated with research articles that have important insights into best practices, theoretical constructs, and proven methods to advance the field. We argue that physical education represents a nexus of opportunity for scholars to connect, collaborate, and disseminate research. The top 100 list serves as a reminder of this notion. Physical education is a relevant topic that garners interest from a range of disciplines and people worldwide.

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