

Evolving Trends in Physiotherapy Research Publications between 1995 and 2015

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ABSTRACT

Purpose: The aim of this study was to comparatively analyze evolving trends in physiotherapy (PT) research publications (excluding case reports and epidemiological and qualitative studies) between 1995 and 2015, inclusively in terms of research design, funding support, age groups, and health conditions. **Method:** This was an observational study using PubMed-indexed data. Combinations of medical subject headings identified yearly research publications for PT and comparator fields: human-based health and physical rehabilitation. Yearly publications data were extracted, relative percentages were computed, and linear or exponential regressions examined the yearly growth in the proportion of research publications over these 2 decades. **Results:** As a percentage of human-based health research publications, PT research publications grew exponentially: from 0.54% in 1995 to 2.37% in 2015 ($r^2 = 0.97$; $p < 0.01$). As a percentage of physical rehabilitation research publications, PT research grew from 38.2% in 1995 to 58.7% in 2015 ($r^2 = 0.89$; $p < 0.01$). Randomized controlled trials (RCTs) resulted in the majority of PT research publications (from 45.1% in 1995 to 59.4% in 2015; $r^2 = 0.79$; $p < 0.01$). Rates of declared funding increased (from 29.7% in 1995 to 57% in 2015; $r^2 = 0.83$; $p < 0.01$), but the comparator fields had similar growth. The percentage of PT research publications remained stable for most health conditions and age groups, decreased for those aged 0–18 years ($p = 0.012$) and for cardiovascular and pulmonary conditions (both $p < 0.01$), and increased for neoplasms ($p < 0.01$). **Conclusions:** PT research publications have become more prevalent among health and physical rehabilitation research publications; the majority of publications report on RCTs.

Key Words: Medical Subject Headings; publications; PubMed; randomized controlled trials as topic.

RÉSUMÉ

Objectif : procéder à l'analyse comparative de l'évolution des tendances des publications de recherche en physiothérapie (à l'exception des rapports de cas et des études épidémiologiques et qualitatives) entre 1995 et 2015 inclusivement, y compris la méthodologie de recherche, le soutien financier, les groupes d'âge et les affections en cause. **Méthodologie :** étude d'observation à partir de données indexées de PubMed. Les chercheurs ont utilisé des combinaisons de vedettes-matières médicales pour dégager les publications de recherche annuelle dans les domaines de la physiothérapie et les domaines de référence santé humaine et réadaptation physique. Ils ont extrait les données des publications annuelles, calculé les pourcentages relatifs et utilisé la régression linéaire ou exponentielle pour examiner la croissance annuelle de la proportion des publications de recherche au cours de ces deux décennies. **Résultats :** en pourcentage des publications de recherche en santé humaine, les recherches en physiothérapie ont connu une croissance exponentielle : de 0,54 % en 1995, elles sont passées à 2,37 % en 2015 ($r^2 = 0,97$; $p < 0,01$). En pourcentage des publications de recherche en réadaptation physique, elles sont passées de 38,2 % en 1995 à 58,7 % en 2015 ($r^2 = 0,89$; $p < 0,01$). Les essais aléatoires et contrôlés (ECT) forment désormais la majorité des publications de recherche en physiothérapie (de 45,1 % en 1995 à 59,4 % en 2015; $r^2 = 0,79$; $p < 0,01$). Le taux de financement déclaré a augmenté (de 29,7 % en 1995 à 57 % en 2015; $r^2 = 0,83$; $p < 0,01$), mais les domaines de référence ont affiché une croissance similaire. Le pourcentage de publications de recherche en physiothérapie est demeuré stable pour la plupart des affections et des groupes d'âge, mais a diminué chez les 0 à 18 ans ($p = 0,012$) et pour les affections cardiovasculaires et pulmonaires (toutes deux $p < 0,01$) et a augmenté pour les néoplasmes ($p < 0,01$). **Conclusion :** les recherches en physiothérapie sont désormais plus fréquentes dans les publications de recherche en réadaptation physique; la majorité sont des EAC.

In the human health field, the quantity of research publications is growing at a rapid rate. Jesus reported, for example, that randomized controlled trials (RCTs) grew by an average of 6% each year between 2001 and 2013,

whereas systematic reviews (SRs) for the same time period grew by 19% per year.¹ Page and colleagues reported a three-fold increase in SRs in the health field between 2004 and 2014.²

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In the physical rehabilitation field, research publications have also increased. Mimouni and colleagues observed a linear increase in the number of publications between 1998 and 2013, with multiplication factors of 3.3 and 2.9, respectively, for adult and paediatric literature.³ Jesus found that between 2001 and 2013, the average yearly growth of published SRs and RCTs was higher for rehabilitation than for the broader health field (SRs: 20.2% versus 18.9%; RCTs: 12.3% versus 6.0%).¹

Rehabilitation has also seen an increase in physiotherapy (PT) research publications over time. For example, the number of RCTs focusing on rehabilitation for mechanical low back pain has risen consistently over each of the past 5 decades.⁴ Using data from the Physiotherapy Evidence Database (PEDro; a comprehensive repository of PT-related trials, SRs, and evidence-based practice guidelines), Kamper and colleagues reported an exponential growth in the number of articles indexed.⁵ As of October 2014, 28,600 PT-related research articles had been published (80.6% RCTs, 17.6% SRs, and 1.8% clinical practice guidelines).⁵

Researchers have also examined PT publication trends for specific, or groups of, physiotherapy journals,^{6–10} often over time. For example, a study of 30 years of the journal *Physical Therapy* found an increase in research-based articles and a decrease in non-SRs and articles focused on anatomy or physiology.⁷ Ways in which articles in PT journals are distributed across health conditions and across age groups have also been examined.^{9,10}

The aim of this study was to comparatively examine changing trends in PT research publications between 1995 and 2015. We concentrated on the relative growth of these publications in the broader human-based health and physical rehabilitation fields, changes in research design, funding support, and focus on age groups and conditions.

METHODS

Search strategy and data collection

For this analysis, we used the PubMed database (<https://www.ncbi.nlm.nih.gov/pubmed>) and the indexing system for its largest sub-component (MEDLINE). Although not exhaustive, PubMed is a comprehensive research database. In the health field, there is evidence that adding searches of other databases to a PubMed search had only a modest impact on the number of SRs found.¹¹ In a sample of PT-relevant RCTs, PubMed indexed 89%; EMBASE, 88%; PEDro, 92%; and CENTRAL, 95%.¹² We used PubMed because it could provide the data needed for both PT and comparator fields, is frequently used by physiotherapists who seek research information to support clinical decisions, and is freely accessible.¹³

In PubMed, Medical Subject Headings (MeSH) are organized in a hierarchical tree and assigned to each paper by trained indexers. Therefore, articles are systematically

indexed by research topic regardless of the key words identified by the authors. This system has been used to examine publication trends and changes in their focus over time for different health fields, including rehabilitation.^{1,3,14–18} In this study, we used a similar approach: we did not manually screen PubMed entries for content or methodology but fully relied on the PubMed indexing system. This strategy was applied to both PT research publications and those of the comparator fields because both had been indexed in the same way – that is, under the same MeSH tree and using the same systematic indexing process carried out by trained personnel.

To inform the PubMed search strategy, we created the following key working definitions and mapped them onto the controlled vocabulary thesaurus of the MeSH tree:¹⁹

- *Human-based health research*: all PubMed-indexed research conducted with humans, as opposed to that conducted only with animals.
- *Physical rehabilitation*: rehabilitation services provided by qualified rehabilitation professionals (physical, occupational, and speech therapists, etc.) to optimize daily and social functioning in people with physical impairments (e.g., impaired mobility, cognition, communication) or symptoms associated with, or secondary to, a physical injury or disease, including neurobehavioral sequelae or associated mental health issues (e.g., post-stroke depression).^{20–24} Services and care focused on the rehabilitation of oral, mental health, or substance abuse conditions or sensory impairments were excluded.
- *PT*: services and care provided to humans by physiotherapists or their qualified assistants or focused on PT intervention techniques, irrespective of the setting in which the service is provided.
- *Research publications*: a set of study designs that systematically evaluate intervention effects (e.g., clinical trials), synthesize knowledge, empirically validate evaluation or intervention tools, or refer to practice guidelines. Case reports and epidemiological and qualitative research publications have a different scope and were not included in this working definition; therefore, they are not examined in this paper.

The online Appendix describes the final search filters we used for the MeSH terms for PT and the comparator fields, research designs (we first searched all research publications, then RCTs and SRs separately), funding support, age groups and health conditions.

In addition to the working definitions, these search filters were informed by previous research. For instance, for the broader rehabilitation field, we used published search filters^{1,3,25,26} but adapted them to match the definition of *physical rehabilitation* – for example, MeSH terms related to mental health were added to the exclusion criteria (using the Boolean operator NOT). For research designs,

we used a published combination of search terms to detect SRs;²⁶ the MeSH tree did not include SRs as a publication type up to 2019. Similarly, for funding support, we replicated a previously published search filter.²⁶ Finally, health conditions previously analyzed for rehabilitation publication trends in PubMed were selected and (re-)grouped as those most likely to be addressed by PT interventions, as decided by the research team.¹

On the basis of these approaches, we conducted target searches in PubMed. We first ran a pilot search with the PT search filter defined either as a major topic or as a simple MeSH term. Although the pattern of results (e.g., relative growth) was similar for both searches, we proceeded with the final searches using PT search terms defined as a major topic. This approach allowed us to capture PT-focused research, rather than research related to PT more broadly, while applying the same strategy to the comparators.

We conducted final searches in December 2017 but narrowed down the range of publication dates to the period from January 1, 1995, to December 31, 2015, to (1) account for the typical 2-year delay in PubMed indexing, (2) capture recent publication trends, and (3) account for the fact that publication types have been systematically indexed in PubMed only since 1991.

Data extraction and analysis

From each search, the yearly volume of publications was imported into Microsoft Excel 2016 (Microsoft Corporation, Redmond, WA) spreadsheets, in which we computed the percentages of the records (e.g., percentage of RCTs among physiotherapy research publications). Because our purpose was to conduct a comparative analysis, all data were analyzed and reported in relative percentages, not in number of publications. We used run charts and then linear or exponential regression models, according to best fit (determined by r^2 values and visual exami-

nation), to analyze any changes in the percentages over the time period studied. We present results only for the models that showed the best fit, whether linear or exponential regression models. If the fit was similar for the linear and exponential models, we retained the linear ones.

For linear regression analysis, we performed t -tests of the slope value to observe whether yearly growth in the percentages of the publications was statistically significant. We performed the same analysis for the exponential regression models, but for log-transformed observations. We considered $p < 0.05$ to be statistically significant.

RESULTS

Relative growth of physiotherapy research publications

The number of PT research publications grew exponentially as a percentage of all human-based research in PubMed (from 0.5% in 1995 to 2.4% in 2015; $r^2 = 0.97$; $p < 0.01$; Figure 1). Similarly, the number of PT research publications grew exponentially as a percentage of all physical rehabilitation research publications (from 38.2% in 1995 to 58.7% in 2015; $r^2 = 0.89$; $p < 0.01$; Figure 2).

Research design

As a percentage of all PT research publications, RCTs and SRs increased linearly over time (for RCTs, from 45.1% in 1995 to 59.4% in 2015; $r^2 = 0.79$; $p < 0.01$; and for SRs, from 0% in 1995 to 14.6% in 2015; $r^2 = 0.95$; $p < 0.01$). As of 2015, RCTs and SRs combined represented 74% of PT research publications, compared with 45% in 1995 (Figure 3).

Funding support

The percentage of PT research publications declaring funding grew significantly and relatively linearly between 1995 and 2015 (from 29.7% in 1995 to 57% in 2015; $r^2 = 0.83$; $p < 0.01$). The growth did not significantly differ,

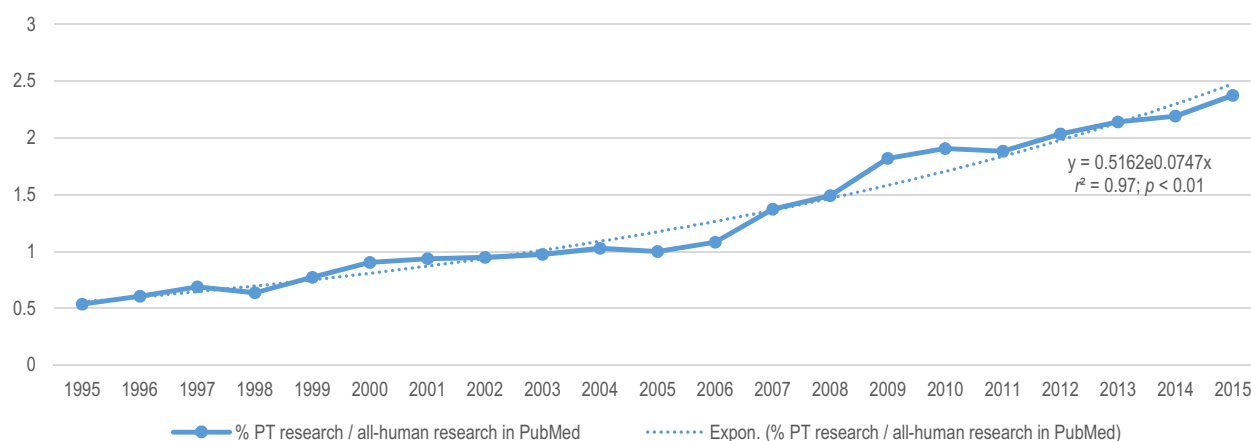


Figure 1 Yearly percentages of PT research publications among all human-based health research publications in PubMed, 1995–2015.

Note: The dotted line represents the exponential regression model.

PT = physiotherapy; Expon. = exponential.

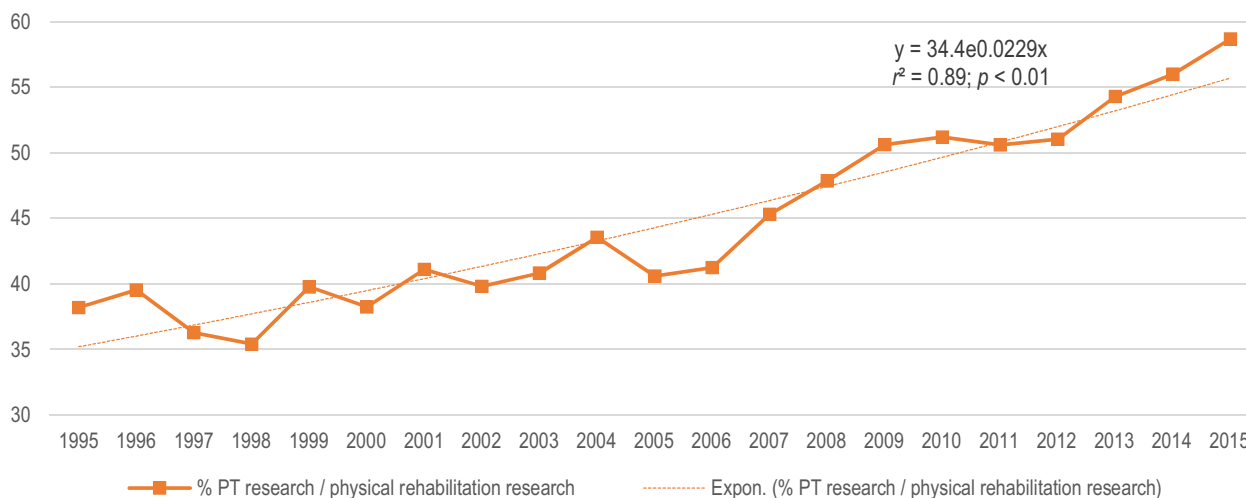


Figure 2 Yearly percentages of PT research publications among physical rehabilitation research publications in PubMed, 1995–2015.

Note: The dotted line represents the exponential regression model.

PT = physiotherapy; Expon. = exponential.

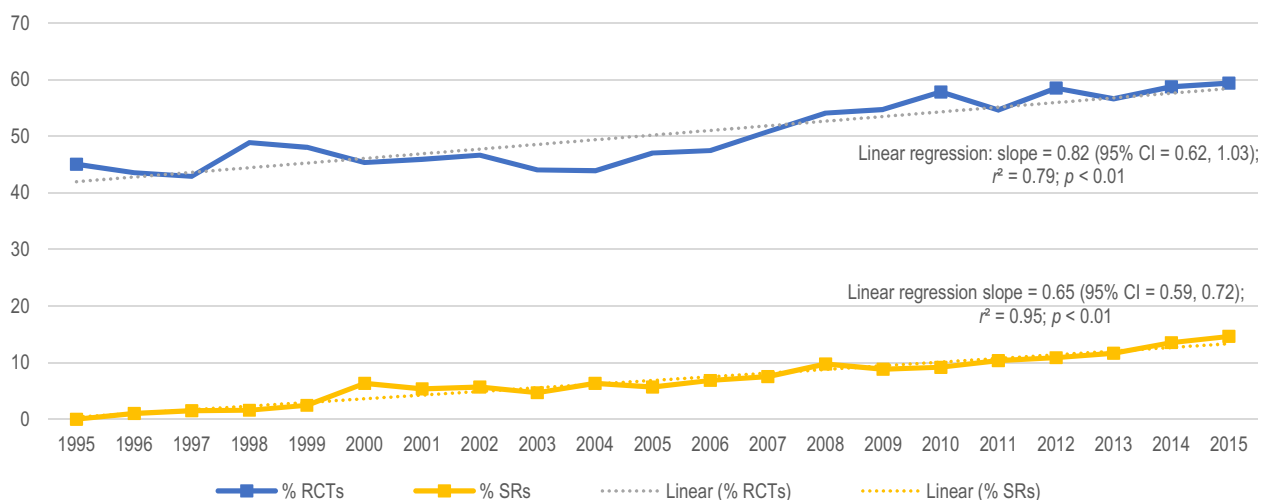


Figure 3 Yearly percentages of RCTs and SRs among physiotherapy research publications, 1995–2015.

Note: The dotted lines represent the linear regression models.

RCT = randomized controlled trial; SR = systematic review.

though, from that of comparator publications – physical rehabilitation, excluding PT, and human-based health research in PubMed; the regression lines are similar among the three fields with 95% CIs for the *t*-tests of the slope values partly overlapping (Figure 4).

Age groups and health conditions

The percentage of studies with individuals aged 0–18 years decreased significantly between 1995 and 2015 (from 22% in 1995 to 17.4% in 2015; $r^2 = 0.22$; $p = 0.03$). There were no significant changes in the percentage of PT research publications involving adults and older people during that time (for adults, from 49.8% in 1995 to 48.6% in 2015; $r^2 = 0.12$; $p = 0.13$; for older people, from

34.4% in 1995 to 38.6% in 2015; $r^2 = 0.13$; $p = 0.11$, respectively; Figure 5).

Studies focused on the nervous system and musculoskeletal conditions were the most prevalent, with no significant changes in percentages over the period studied ($p > 0.05$). However, the percentage of PT research publications focused on neoplasms (cancer patients) significantly increased and more than doubled (from 1.8% in 1995 to 4.3% in 2015; $r^2 = 0.67$; $p < 0.01$). The percentage of studies on cardiovascular and pulmonary health conditions showed significant decreases: from 9.5% in 1995 to 8% in 2015 ($r^2 = 0.53$; $p < 0.01$) and from 5.9% in 1995 to 5% in 2015 ($r^2 = 0.46$; $p < 0.01$), respectively (Figure 6).

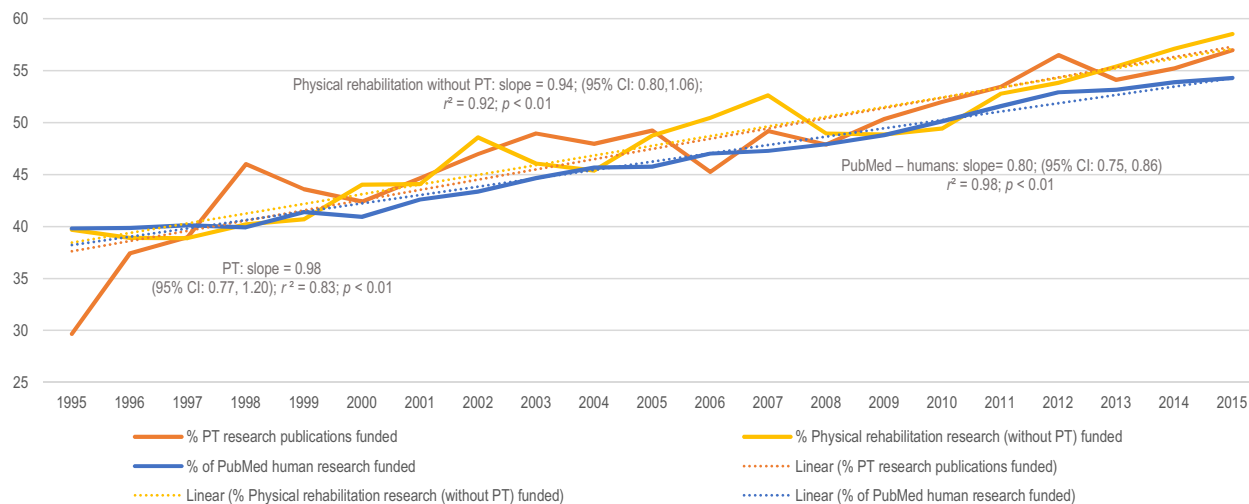


Figure 4 Yearly percentages of publications declaring funding support for PT, physical rehabilitation without PT, and all human-based health research in PubMed, 1995–2015.

Note: The dotted lines represent the linear regression models.
 PT = physiotherapy.

DISCUSSION

PT-focused research publications have become more prevalent among human-based health and physical rehabilitation research publications, with exponential growth in the percentages of both observed between 1995 and 2015. In fact, in that time, they became the majority of physical rehabilitation publications. In research design, RCTs became the majority of these publications. Although the percentage of PT research publications remained stable for most population groups, it was significantly re-

duced for the pulmonary and cardiovascular populations and for individuals aged 0–18 years and significantly increased for neoplasms.

The increase in the percentage of research publications devoted to PT may be part of an increased awareness, around the world, of the need to advance the physiotherapy evidence base.²⁷ It may also reflect the increase in the number of physiotherapists who have entered the field with graduate degrees and who are trained in research. In addition, research has been incorporated

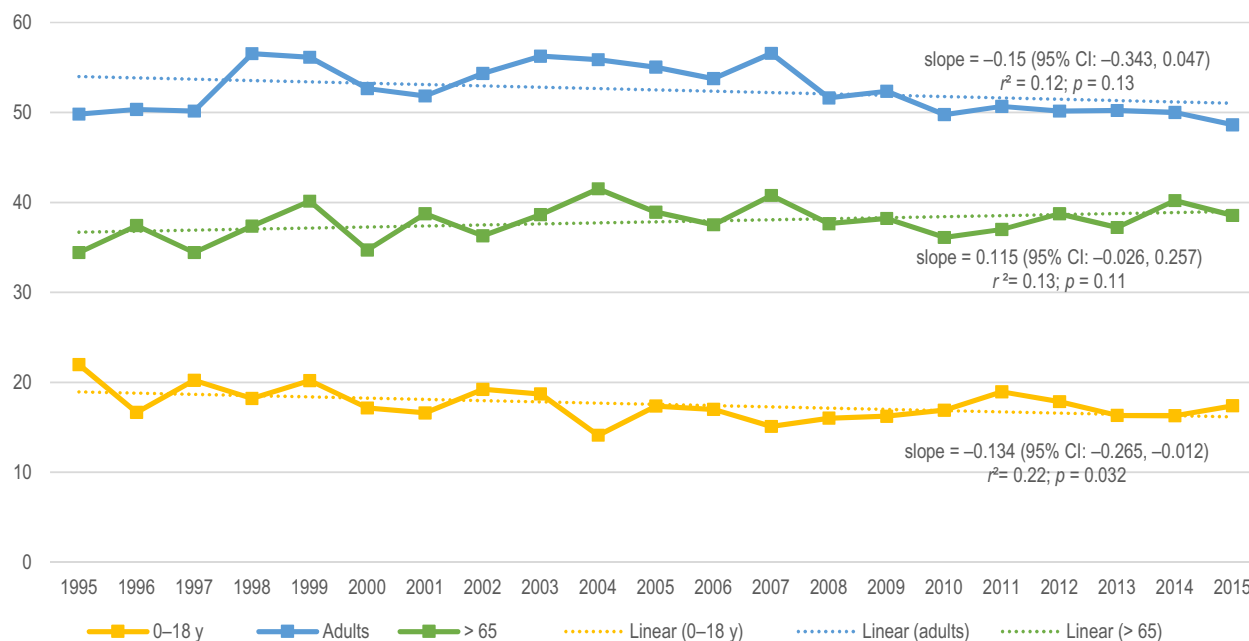


Figure 5 Yearly percentages of physiotherapy research publications across the age groups of treated populations, 1995–2015.

Note: The dotted lines represent the linear regression models.

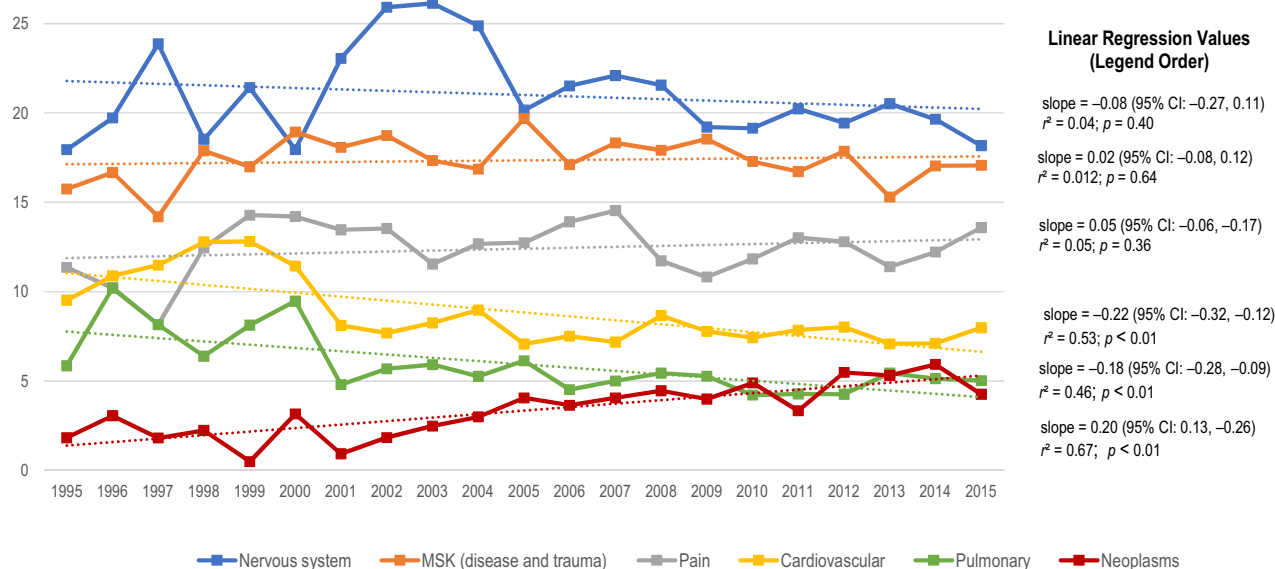


Figure 6 Yearly percentages of physiotherapy research publications, 1995–2015, across the main groups of health conditions. Note: The dotted lines represent the linear regression models. MSK = musculoskeletal.

into the curriculum at many PT schools; as a result, the number of research projects and publications from students and faculty has increased.^{28–32} Nurturing the research requirements in the education of physiotherapists is likely key to increasing the PT evidence base, now and in the future.

It is also possible that physiotherapy researchers are more likely to publish their research work in journals indexed by PubMed and that rates of conversion of physiotherapy research into full-text publications have increased. Whereas an early study found under-publication of full texts for orthopedic and sports physical therapy abstracts presented at a relevant meeting,³³ a follow-up study found an increase of more than 50% in full-text publication rates for abstracts presented at that meeting for a subsequent time period.³⁴ In addition, PT research publications may increasingly be indexed as being physiotherapy focused in the PubMed database. For example, the MeSH term *physical therapists* has been available since only 2012, whereas *nurses* was available in 1967.

We noted an increase in the percentage of research publications declaring funding support overall – that is, this trend was not exclusive to or higher for PT. We found that the increase in funding support has not directly increased the number of PT research publications as a percentage of human-based health and physical rehabilitation research, even though it likely has contributed to increasing the number of PT research publications. However, research funding may be associated with the quality of PT research publications. A recent survey of 210 published trials in musculoskeletal PT found that funding support was positively associated with the quality of trial conduct

and reporting.³⁵ Moreover, the quality of PT research publications has increased over the years,⁶ although important quality gaps remain.^{36–42} Further investigation of the relationship between funding support and the quantity and quality of PT research is warranted.

We observed that RCTs were becoming the majority of the selected PT research publications: they exceeded 50% in 2007 and increased to about 60% in 2015. For the broader rehabilitation field, which also relied on PubMed-indexed data, the percentage of clinical trials (including research designs other than RCTs) exceeded 50% only in the last year under analysis – 2013.¹ We also found that RCTs and SRs combined accounted for about 75% of PT research publications in 2015. When we considered broader rehabilitation trends, SRs and clinical trials accounted for only about 60% of research publications in 2013.¹ Overall, the rates of RCTs, and of RCTs and SRs combined, seem higher in PT than in the broader rehabilitation research. Despite the strength of RCTs and SRs, observational studies have been important in advancing the rehabilitation knowledge base,⁴³ as have studies on the psychometric properties of outcome measures.^{44,45} Nonetheless, designs with strong internal validity, such as RCTs, strengthen the evidence base for specific PT interventions.

Emerging fields of PT practice may have generated new opportunities for conducting research. For example, we observed a significant increase in the percentage of PT research publications focused on neoplasms. In contrast, we observed a significant decrease in the percentage of these publications that focused on pulmonary and cardiac health conditions over the time period we studied, despite the increase in their number. In PEDro, the

subdiscipline of cardiothoracics was, of 10 PT subdisciplines, the second highest represented in the number of articles available and number of searches,^{5,46} whereas the oncology subfield had one of the lowest numbers of searches,⁴⁶ and its trials were among those that had lower quality scores.³⁶

We observed that physiotherapy research publications on neoplasms grew from a nearly residual value, less than 2% in 1995, to more than 4% in 2015. With increasing cancer survival rates and greater value attributed to physical exercise and rehabilitation among cancer survivors, more PT research publications have emerged in this area.⁴⁷ In turn, the evidence for pulmonary and cardiovascular PT practice might have been established sooner; it is now a major target for knowledge translation and implementation endeavors.^{48–50}

We found no significant change over time in the percentage of PT research publications focused on nervous system, musculoskeletal, or pain conditions. This contrasts with the broader rehabilitation field, for which publications of SRs and trials on nervous system conditions were more than double those for musculoskeletal conditions in 2013, whereas in 1997 they were relatively equal. Musculoskeletal conditions, including back and neck pain, are among the leading causes of disability and among the costliest to the health system.^{51–53} Therefore, the observed trend in PT research publications, compared with those in the broader rehabilitation field, appears more aligned with epidemiological data and health system needs.

The percentage of PT research publications aimed at the adult and older populations remained relatively stable, although there was a significant reduction for the youngest age group (aged 0–18 y). Across the globe, the rate of people aged 65 years and older is increasing and expected to double by 2050, whereas the overall population is expected to grow by less than 30%,⁵⁴ although these demographic trends were not reflected in the PT research. Changing demographics do not, though, necessarily result in a growth in research questions, and perhaps a peak, or ceiling, in the percentage of PT research focused on older populations has been achieved. However, a higher percentage of the population will benefit from PT research focused on older populations. Matching research production with societal and research needs is a complex matter increasingly fostered and analyzed in the broader health field.^{55–59} Systematically collecting and synthesizing data on publication trends, funding, methodological quality, knowledge gaps, and epidemiological and demographic data could help stakeholders establish PT research priorities.

This study has several limitations. First, it only reports on PubMed data; hence PT research publications not indexed in this database (i.e., those indexed only in CINAHL, PEDro, EMBASE, etc.) were not counted. Second,

we analyzed the volume of PT research publications, not the quality. Third, we did not manually screen PubMed entries for content or methodology but relied on the PubMed indexing system. Fourth, some search terms and filters may have been more reliable than others: for a long time, PubMed did not include a specific MeSH term for SRs, although that was recommended.^{2,60} Fortunately, since 2019, newly published SRs can be indexed as such: SR is now a publication type in the MeSH tree. In the future, this will help identify and locate SRs in PubMed.

Fifth, we searched for MeSH terms mostly as major topics. This means that PT-related research (research indexed for a PT-related MeSH term but not as a major topic) was not included. Thus, not all the research of potential relevance to PT was considered. Sixth, PT research that did not focus on a given health condition as a major topic was not included in the distribution of PT research publications by health condition. This explains why the sum of the percentages across the analyzed health conditions for a given year is less than 100%. The focus on health conditions treated allowed us to compare them with the rehabilitation research literature; however, it does not necessarily reflect the subdisciplines of PT practice. Seventh, we did not include case reports or epidemiological or qualitative studies in the set of research publications; as a result, not all research was included.

Eighth, we addressed SRs overall (within a range of systematic approaches to knowledge synthesis),^{25,26,38,61,62} without distinguishing between or making separate analyses for, for example, SRs overall and the sub-group of those with meta-analysis; a previous analysis took this approach for the rehabilitation field.¹ Despite this limitation, we acknowledge that under the right circumstances (e.g., focused study questions on intervention effects; homogeneous interventions, study designs, and contexts), SRs with meta-analysis are the methodological gold standard within the SR approach. Ninth, although working definitions were created to inform the selection of search terms, there were still grey areas – for example, in the inclusion or exclusion of what pertained to physical rehabilitation. Finally, although we analyzed the rates of declared funding support, we did not analyze the amount of that support, its relative growth, or the underlying financing mechanisms.⁶³

CONCLUSION

Between 1995 and 2015, the percentage of PT research publications in the human-based health and physical rehabilitation fields has grown significantly – that is, we observed a significant relative growth in the volume of PT research publications. These publications declared funding support at increasing rates over these 20 years, but this growth rate was similar to that for comparator fields.

The distribution of PT research publications was relatively stable across most age groups and health conditions;

adult populations and nervous system, musculoskeletal, and pain conditions were consistently the most frequently addressed. Significant changes occurred only for other populations: there was a significant decrease in focus on the younger population (aged 0–18 years) and on cardiac and pulmonary conditions, whereas there was a significant increase in publications addressing neoplasms. This seems to be an emerging area for these publications.

Finally, RCTs alone accounted for more than half of all PT research publications and, along with SRs, accounted for nearly three-quarters of them: these research designs are increasingly being used to provide higher levels of scientific evidence.

KEY MESSAGES

What is already known on this topic

Although the volume of health and rehabilitation research has been increasing exponentially over time, how the number of research publications in the physiotherapy (PT) field compared with that trend was unknown. Also unknown was whether any significant changes had occurred in research design, funding support, age groups, or health conditions.

What this study adds

Between 1995 and 2015, the percentage of PT research publications grew exponentially among both human health and physical rehabilitation research publications, revealing a significant gain in the relative volume of research. Randomized controlled trials became the majority of PT research publications, revealing greater rigour in study design choices. These publications declared increasing rates of funding support, but the trend was similar to that of comparator fields. The percentage of these publications focused on most health conditions and age groups remained stable, but it decreased for those focused on individuals aged 0–18 years and on cardiovascular and pulmonary conditions. However, the percentage significantly increased for publications focused on neoplasms.

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