Abstract

Background: Prior studies report that most published medical education research is unfunded. We sought to determine the extent and sources of funding for medical education research articles published in leading journals, and how these have changed in the last two decades.

Methods: All research articles published in *Academic Medicine, Advances in Health Sciences Education, Medical Education and Medical Teacher* in 1999, 2004, 2009, 2014 and 2019 were reviewed for funding declarations. Funding sources were categorised as: government; university; healthcare organisation; private not-for-profit organisation; and for-profit company. Time trends were analysed using the Cochran-Armitage test.

Results: 1822 articles were analysed. Over the aggregate twenty-year period, 44% of all articles reported funding, with the proportion increasing from 30% in 1999 to 50% in 2019 (p<0.001). The proportion of articles with government (10% to 16%, p=0.049), university (6% to 17% p<0.001), and not-for-profit funding sources (15% to 20%, p=0.04) increased. Proportions of healthcare (3% to 4%, p=0.45) and for-profit funding (2% to 1%, p=0.25) did not significantly change with time.

Conclusions: Over the last 20 years, the proportion of funded published medical education research has significantly increased, as has funding from government, universities, and not-for-profit sources. This may assist researchers in identifying funders with a track record of supporting medical education research, and enhances transparency of where research funding in the field originates.

Keywords/MeSH terms: funding; Education, Medical; Research Support as Topic; Trends; Periodicals as Topic

Practice points

- Over the last 20 years, an increasing proportion of research articles in four leading medical education journals have reported funding.
- This is encouraging, as funding has previously been associated with greater research quality.
- However, 50% of published medical education research articles in 2019 appeared to be un-funded.
- Government, university, and private not-for-profit organisations were the most common sources of funding.

Introduction

In recent decades, scholarly productivity in medical education has grown dramatically, as indicated by increases in the size and number of dedicated medical education conferences across the world and the number of medical education publications and journals (Ten Cate 2021). Published medical education research has historically suffered from small sample sizes, single-site designs, and lower-order outcome measures that are difficult to extrapolate to practice improvement (Albanese 1998). As such, medical education research does not always translate to practice changes (Archer et al 2015; Horsley et al 2020).

There is literature to support the value of funding for medical education research. In 2007 it was demonstrated that an association existed between funding and some indicators of medical education research quality (Reed et al 2007), supporting calls for funding for medical education research – separate from funding for medical education generally (Dauphinee & Wood-Dauphinee 2004; Asch & Weinstein 2014). However, concerns have continued to be raised about the limited funding available to support medical education research (Asch & Weinstein 2014; Archer et al 2015).

Some medical education scholars have argued that the dearth of dedicated research grants in their field mean that education scholars should be “creative, flexible, and adaptable” in their pursuit of finding funds (Gruppen et al 2016). However, others suggest that more widespread, systemic action is needed, and there have been impassioned and compelling calls from educational researchers in the US and the UK to increase dedicated funding streams for medical education research, to improve research quality and drive innovation in the teaching and training of doctors (Reed et al 2005; Archer et al 2015). When research is not specifically funded, there is a danger that – lacking a ring-fenced source of funds - it will not be reflected in job plans for clinicians either. This in turn can have implications on an educator’s time resources in addition to the financial impact.

Despite the increase in volume of medical education articles over the last few decades, it has not yet been clearly established if there has been a corresponding increase in funding. It is also unknown whether the sources of medical education research funding have changed over time – information that is highly relevant for researchers seeking grant applications.

We set out to assess the funding of published medical education research over a recent 20-year period to better understand if previous calls have since been heeded; a similar two-decade approach has recently been used to assess funding trends in health professional education elsewhere (Wu et al 2021).

Methodology

This was a quantitative study, grounded in a post-positivist research paradigm (Bunniss & Kelly 2010). The four journals (*Academic Medicine, Advances in Health Science Education, Medical Education, and Medical Teacher*) with the highest InCites Journal Impact Factor of general medical education journals within the category "Education, scientific disciplines" were selected for study (InCites 2020). All four journals' editorial offices were contacted by email in March 2020 to determine their current and historical policies on funding declarations for accepted articles.

Search and inclusion strategy

We sampled all articles published at 5-year intervals by visiting the websites of each journal to identify all published articles indexed in the 1999, 2004, 2009, 2014, and 2019 issues of those journals. Articles that were published online in those years but were indexed in a journal issue in a different year (e.g., published online in 2009, indexed in journal issue in 2010) were not included.

We identified research articles as those that had abstracts and followed the basic Introduction, Methods, Results, and Discussion (IMRaD) structure (Huth 1987). Some articles – for example, those describing and evaluating an educational intervention – did not contain these exact headings but contained ones that were analogous (e.g., Purpose, Development, Outcomes, Evaluation). We included these as well, using coders' judgement on each paper as to whether they were sufficiently equivalent to IMRaD. Two authors (DGJM & NAS) independently reviewed article abstracts and judged whether to include or not. Disagreements were adjudicated by a third author (MAR).

Analysis of funding sources

Two authors (DGJM & NAS) scrutinised each article for the presence of a funding declaration under the Acknowledgements, Declarations, Conflict of Interests, and (if present), the Funding headings of the manuscript. Articles were categorised into the following:

- Funding status unknown (no statement of funding)
- Funding status declared, and stated to be 'unfunded', 'no external funding' or similar
- Funding status declared and attributed to an organisation. We interpreted statements that work had been 'supported' by an organisation as a declaration of funding from that organization (e.g., "supported by the Robert Wood Johnson Foundation"). "Supported" might mean direct funding or in-kind support; this was not clarified in articles, and so we assumed it represented direct or indirect financial support of some kind in our analyses.

Based on our experiences with seeking funding, and a pilot review of articles, we sub-categorised articles that had received funding into one or more of the following categories:

- received funding from a federal or regional government organisation (e.g., National Institutes of Health)
- received funding from a named university
- received funding from a healthcare institution (e.g., a named hospital)
- received funding from a non-governmental, not-for-profit organisation, including private charitable foundations (e.g., the Arnold P. Gold Foundation) and professional bodies not included within the categories above (e.g., Royal College of Physicians)
- received funding from for-profit corporations (e.g., GlaxoSmithKline)

Statistical analysis

Statistical analysis was performed using Stata 17.0 (StataCorp, College Station, TX). Trends over time in the proportions of articles that received funding, and the proportions receiving funding from each specific source detailed above, were analysed using the Cochran-Armitage test, a modification of the Chi-square test used to assess for the presence of a linear trend between a binary response variable (i.e. funded yes/no) and an ordinal explanatory variable (i.e. calendar year: 1999/2004/2009/2014/2019) (Cochran, 1954).

Results

Sample characteristics and proportion of funded articles

A total of 1822 eligible articles were included. The number of included articles from each journal in each year is given in Table 1. Articles from 1999 made up a disproportionately small set of the sample (n=226, 12% of total), and the opposite was true for articles from 2009 (n=529, 29% of total). One reason for the increase in 2009 was a high number of articles in *Medical Teacher,* which included an additional “Web Paper” category, where full articles were published online, and the abstracts of those articles indexed in the print journal. By 2014, this category was no longer published, and those articles were either indexed or published elsewhere.

Funding disclosure requirements of journals

Editorial staff at all four journals reported that their current policy is to request funding declarations from all authors. The editorial staff could not give precise dates of implementation of this policy. We then manually scrutinised author guidelines in original paper copies of the journals to achieve greater precision. In January 1999, *Medical Education* stated, “information concerning funding for the work described should be included in the manuscript", whereas *Academic Medicine* at that time instructed authors to provide a statement about any conflict of interest, including financial, and specified that “if there is even a possible conflict of interest, the authors must describe the circumstances”. The 1999 editions of *Advances in Health Sciences Education* did not contain advice to authors regarding funding declarations, but in 2004, stated that “people, grants, funds etc.” should be acknowledged in submitted papers. *Medical Teacher* did not request declarations of funding in 1999; in 2004, it required authors to make “an appropriate statement should you have a financial interest or benefit arising from the direct applications of your research” but made no specific mention of funding for submitted research. By 2009, author instructions had moved entirely online, and these were not indexed at archive.org. The editorial team of *Medical Teacher* reported that funding declarations had been required since “at least 2010”, which is the best estimate we were able to reach for that journal.

Funding sources

Funding sources for included articles are given in Table 2 and shown in Figure 1. 738 (41%) articles did not contain a funding statement. 282 (16%) contained a declaration that they did not receive funding. Of the remaining 802 (44%) which did declare funding support, government (n=330, 18% of all articles, 41% of funded articles), university (n=264, 14% of all articles, 33% of funded articles) and non-profit (n=276, 15% of all articles, 34% of funded articles) organisations were the most common sources of support, with funding from healthcare (n=68, 4% of all articles, 8% of funded articles) and for-profit entities (n=45, 2% of all articles, 6% of funded articles) being relatively uncommon.

Changes to funding over time

The proportion of articles declaring funding received increased from 30% in 1999 to 50% in 2019, with a statistically significant trend over time (p<0.0001) (see Figure 1).

Articles were more likely to contain a funding statement (either declaring that financial support was received, or that no support was received) in recent years (n=68, 30% in 1999, to n=293, 76% in 2019, p for trend <0.0001).

The proportion of articles reporting government funding increased from 10% in 1999 to 24% in 2014, with a fall to 16% in 2019. Over the whole time period, this trend was not statistically significant (p=0.06). The proportion of university-funded papers increased from 6% in 1999 to 18% in 2014 and 17% in 2019 (p for trend <0.001), and non-profit-funded papers increased from 15% in 1999 to 20% in 2019 (p for trend 0.04).

There was no evidence for a changing trend in the proportion of articles funded by healthcare (p=0.45) or for-profit (p=0.25) organisations over time.

Discussion

We have demonstrated that over the past two decades, the proportion of medical education research articles that reported research funding in four leading journals has significantly increased. However, funded research still represented only half of the published research in those journals as of 2019.

The trend of an improving proportion of funded published work appears encouraging. In biomedical science research, it has recently been demonstrated how strong the association between funding and publication can be. Of 27,016 National Institutes of Health (NIH) primary grants awarded, 97.6% achieve an associated publication within 60 months of the project start date (Riley et al 2020). Funding has been associated with improvements in the quality of medical education research design and conduct (Reed et al 2007; Albanese et al 1998; Hart and Harden 2000). Improvements in quality may be reflected in the conversion rates of medical education conference abstracts to full publications (considered a proxy of research quality), which have been reported to be similar to that for biomedical research, and may be increasing (Walsh et al 2013; Sawatsky et al 2015). The professionalization of health professions education may also be attracting more financing. The last two decades covered by our study have seen widely published structures to further improve medical education research (Harden et al 1999; & Sullivan et al 2014). Applying such structures to educational research may be generating a virtuous cycle as quality improvement drives increased funding. Given that there are also now increasing efforts underway to train, support, and recognise research skills amongst clinical educators, increased funding support may still be of great benefit (Ahmed 2014).

Of the articles that reported funding, government, university, and private non-profit organisational grants were the most common sources. In contrast, funding from healthcare organisations and for-profit corporations was far less common. The relative absence of for-profit funding stands in stark contrast to clinical research, where industry funding is commonplace (Røttingen et al 2013). Funding sources for biomedical research funding in the USA have been estimated to overwhelmingly come from industry (58%) or the federal government (33%) rather than from institutions such as universities (Dorsey et al 2010). This might reflect a relative lack of profit-making opportunities in medical education compared to the pharmaceutical and medical device markets; this however may well change as the commercial medical education sector expands (Shomaker 2010). We demonstrated that 44% of all funded articles we reviewed had received funding from the broad 'government' category, including national, regional and local government sources. This may reflect an increased recognition of the importance of medical education systems to society, and perhaps that efforts for medical education to be more socially accountable are being rewarded (Lindgren and Karle 2011).

A recent study used similar methodology to our paper to examine trends in funding sources for clinical research papers published in the ten highest impact general medical journals (Burciaga-Jimenez et al 2022). In contrast to our findings, funding for clinical research papers was much more commonplace (at least 84% of papers had a clearly-defined funding source, and all papers were assumed by the authors to have been funded). Government (60%) and industry (16%) were much more common sources of funding for clinical research papers than we found within the medical education literature. The proportion of government and non-government-non-industry funded papers decreased slightly over time in that study; our findings do not, therefore, seem to reflect wider changes in funding behaviour in clinical and biomedical science.

Numerous published articles have considered the challenges of applying for biomedical science research funding (for example: Niederhuber 1985; Brownson et al 2015; Eastwood et al 2012; Kozlowski and Rose 2018). However, published guidance on applying for medical education research funding is far sparser. From such guidance which is currently available comes Blanco and Lee's first recommendation to medical educator researchers seeking funding: namely, to contact their own institution's Development Office and Medical Education department, both for advice on external funding, and also to check for internal institutional/university opportunities of funding (Blanco and Lee 2012). Blanco and Lee went on to recommend medical education researchers to also consider seeking funding from national level medical organisations. Our findings helped validate this advice, given that a third of all the funded papers we reviewed had funding from university sources. Our findings also demonstrate a significant increase in the proportion of funded medical education research articles with sources from government, university and not-for profit organisations. Of these only one reached a statistically highly significant value for trend analysis-this was the increase in proportion of published articles having university funding, the proportion increasing from 6% in 1999 to 17% in 2019. This data provides evidence that medical education research funding from institutional sources has indeed increased in the last two decades in keeping with the recommendation in 1998 for this change (Albanese et al 1998).

Strengths and limitations

This study had a large sample size, including 1822 unique articles in four major medical education journals over a 20-year period. There are several limitations to this study. Some funding bodies may mandate funding declarations in all related research outputs, whereas others may not, leading to under-estimation. It is possible that this requirement may differ by the type of funding; for example, government and university funding sources might be more likely to mandate declarations to demonstrate impact, whereas industry might not, potentially leading to differential misclassification bias. Two of our selected journals had requirements in place prior to our study's start date for prospective authors to declare funding on submission, although even in these journals, the outcome was not always clear from the final published work. It seems logical to assume that any funding - having been specifically requested at submission by the journals - would have been highlighted in the final published version. Furthermore, guidelines requiring medical journals to report any financial support for published work, have been well established at least since the 1979 International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (Anonymous 1979). This cannot however absolutely be verified for all articles. Two further journals implemented funding declaration requirements later in the period of investigation, which may have led to reporting bias throughout the study.

It might be argued that medical education research can be less costly than biomedical research and that small amounts of local funding might suffice. However, hard evidence to support or refute this conjecture is difficult to find, reflecting the relative scarcity of publications examining the cost of medical education research (Cook & Beckman 2015). For example, a systematic review comparing studies in simulation based medical education found that only 6.1% of studies mentioned costs at all, with only 1.6% providing comparisons of costs between alternative strategies (Zendejas et al 2013). This reflects the relative lack of existing information about such costs. A strength of our current study is that it adds to our existing knowledge on the funding of published medical research.

Finally, we had used the four leading medical education journals throughout our work as a surrogate for the wider picture of medical education published research. Although we have justified this approach with examples of similar selected journal studies from past literature, it is possible that the resulting data may not be totally applicable to all medical journals. As funding has previously been shown to be associated with at least some metrics of quality, it could be argued that if higher ranking journals attracted higher quality papers, there is a possibility that a greater proportion of these would be funded.

Directions for future research

Future studies could attempt to replicate our data in other medical education journals or distinguish between different types of research articles. Stratification of studies by methodological quality, utilising tools such as MERSQI, might also be a future approach (Cook and Reed 2015). Analysis of the trend towards increased funding could be further explored, perhaps via qualitative work with applicants and recipients of funding, and representatives of funding bodies. This work could explore how researchers perceive the ease of obtaining funding, and what factors influence their decision to disclose funding sources in published work. Policy-focused research could also examine opportunities for national and international funding agencies in healthcare, social sciences, and higher education to provide explicit grant opportunities to fund medical education research.

Conclusion

We have provided evidence that the proportion of funded published research articles in leading medical education journals has increased in the last two decades. We have considered positive attributes (included potential research quality) that may be associated with funding. Funding from government, university and private non-profit organisations has become more frequent over this period, which may reflect changing priorities that recognise the important role medical education research and scholarship can play in championing high-quality healthcare. However, fully half of the studied articles, even in 2019, did not reported funding. Whilst not all publications will require funding, still further increases in the proportion of medical education research articles achieving funding is a goal for the future that is worth aiming for.

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Table 1: Number of eligible articles included per journal, per year, and as a percentage of the total articles for that journal throughout the 20-year study period.

		Year					Total articles per journal over study period
		1999	2004	2009	2014	2019	
Journal	Academic Medicine	79 (11%)	108 (16%)	198 (28%)	154 (22%)	156 (22%)	*695 (100%)*
	Advances in Health Sciences Education	11 (7%)	21 (13%)	53 (32%)	38 (23%)	44 (26%)	*167 (100%)*
	Medical Education	98 (21%)	100 (22%)	114 (25%)	72 (16%)	72 (16%)	*456 (100%)*
	Medical Teacher	38 (8%)	93 (18%)	164 (33%)	94 (19%)	115 (23%)	*504 (100%)*
Total articles		*226*	*322*	*529*	*358*	*387*	**1822**

Table 2: Number and percentage (per total number of articles that year, or articles over entire study period) of articles that contained a statement of funding. Note that some articles received funding from multiple different funder categories. *p* values are from Cochran-Armitage tests for trend over time.

	Year					*p* for trend over time	Total
	1999	2004	2009	2014	2019		
Received funding from any source (%)	68 (30%)	141 (44%)	214 (40%)	187 (52%)	192 (50%)	<0.0001	802* (44%)
Funded by government (%)	23 (10%)	56 (17%)	105 (20%)	87 (24%)	60 (16%)	0.06	331 (18%)
Funded by university (%)	14 (6%)	47 (15%)	70 (13%)	66 (18%)	67 (17%)	0.0002	264 (15%)
Funded by healthcare system (%)	7 (3%)	12 (4%)	15 (3%)	19 (5%)	15 (4%)	0.45	68 (4%)
Funded by foundation/ private non-profit organisation (%)	33 (15%)	47 (15%)	65 (12%)	55 (15%)	78 (20%)	0.04	278 (15%)
Funded by for-profit organisation (%)	4 (2%)	13 (4%)	13 (3%)	10 (3%)	5 (1%)	0.25	45 (2.5%)
Funding status unknown/undeclared (%)	158 (70%)	145 (45%)	262 (50%)	79 (11%)	94 (13%)	<0.0001	738 (41%)
Specifically stated to be unfunded (%)	0	36 (11%)	53 (19%)	92 (26%)	101 (26%)	<0.001	282 (16%)
Total number of articles analysed per year	226	322	529	358	387		1822

*647 papers received funding from one category only; 155 received funding from 2 or more categories.

Fig 1. Percentage of articles, per year, receiving funding from any source, and from specific sources.