Dry needling curricula in entry-level education programs in the United States for physical therapists

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ABSTRACT

Objectives: The objective of this paper was to determine the extent to which dry needling is instructed in entry-level education programs for physical therapists. **Methods:** Program directors from 226 entry-level education programs recognized by the Commission on Accreditation in Physical Therapy Education were recruited via e-mail to participate in an anonymous 35-item electronic survey during the 2017-2018 academic year. The survey evaluated dry needling curricula, faculty qualifications, attitudes and experience, and programs' future plans for teaching dry needling. **Results:** A total of 75 programs responded to the survey (response rate = 33.1%). Forty (53.3%) had integrated dry needling theory and psychomotor training into their programs and 8 (10.6%) planned to include such content in their curriculum in the future. Of the 40 respondents, 28 indicated that dry needling education was integrated into a required course, 4 indicated that dry needling was an elective course, and 8 did not specify how dry needling education was integrated. Faculty teaching dry needling appear to be well qualified, with the majority having 5-10 years of experience using dry needling in clinical practice. The primary reason for programs not teaching dry needling is that it was not considered an entry-level skill. **Discussion:** There appeared to be variability in how dry needling was integrated into the curricula, as well as in the depth and breadth of instruction. Our research may serve as a baseline for faculty to assess existing dry needling curricula and as a guide for developing curricula in new or existing physical therapy programs.

KEYWORDS

Dry needling;
neuromusculoskeletal
disorders; entry-level
education; physical therapy

Introduction

Physical therapists routinely use a variety of interventions in the management of patients with musculoskeletal disorders. One intervention that has recently gained popularity is dry needling, which is a technique used to treat dysfunctions of skeletal muscle, fascia, nervous and connective tissue through mechanical disruption of tissue without the use of an anesthetic in an effort to reduce pain, alleviate impairments, and diminish activity limitations and participation restrictions [1,2]. As dry needling becomes more commonly used by physical therapists, it is important to continually appraise the existing evidence regarding its effectiveness [3,4,5,6,7,8,9,10,11,12], as well as evaluate the skills a physical therapist would need to perform dry needling safely and effectively [13].

Several systematic reviews have concluded that there is evidence to suggest that dry needling is more effective for musculoskeletal conditions in the short-term (i.e., up to 12 week follow up) for decreasing pain and improving function when compared to sham, placebo, or other treatments such as soft tissue techniques for myofascial chronic neck pain, trigger point compression for myofascial trigger points in the

upper trapezius muscle, stretching for myofascial pain, best evidence physical therapy interventions for postoperative shoulder pain, and proprioceptive/strengthening exercises for chronic ankle instability [3,4,5,6,7,8,9,10,11,12]. There is limited long-term evidence to support dry needling for decreasing pain and improving functional outcomes [5]. Although additional high-quality studies with long-term outcomes are needed to further determine the effectiveness of dry needling on musculoskeletal conditions, dry needling has been shown to decrease musculoskeletal pain and improve functional outcomes in the short-term and may serve as an important intervention in the management of patients with musculoskeletal disorders.

In 2013, the American Physical Therapy Association Public Policy, Practice, and Professional Affairs unit produced an Educational Resource Paper titled 'Description of Dry Needling in Clinical Practice'. The document was created to provide physical therapists with background information and instruction in the performance of dry needling [13]. Dry needling targeted tissues (i.e., trigger points, connective tissues) were defined, the physiological basis for dry needling

treatment was discussed, and indications and precautions were described. The procedure was operationally defined as a skilled intervention exclusively performed by physical therapists that uses a thin filiform needle to penetrate the skin and stimulate underlying myofascial trigger points, muscular, and connective tissues for the management of neuromusculoskeletal pain and movement impairments. The question remained, however, as to what observable knowledge, skills, and/or abilities a physical therapist would need to possess to perform dry needling safely and effectively.

Subsequently, in 2015 the Federation of State Boards of Physical Therapy convened an expert panel to participate in a practice analysis of the competencies required of physical therapists to perform dry needling [14]. The results indicated that 86% of the knowledge requirements needed to be competent in dry needling may be acquired during the physical therapy entry-level education (i.e., knowledge related to evaluation, assessment, diagnosis and plan of care development, documentation, safety, and professional responsibilities) and 14% of the knowledge requirements must be acquired through post-professional education [14]. There is currently no record of how many entry-level education programs offer dry needling in their physical therapy curriculum. In order to better understand and guide the development of dry needling curricula, an 'inventory' of the current entry-level education programs for physical therapists' dry needling curriculum is necessary. Therefore, the purpose of this study was to determine the extent to which dry needling is instructed in entry-level education programs for physical therapists. More specifically, this survey based study investigated 1) whether dry needling is being taught and, if so, how the content is being integrated into the entry-level curriculum, 2) the educational resources used for instruction by the faculty, 3) how student knowledge and skills were assessed, 4) the level of perceived competence of students as viewed by faculty, and 5) the qualifications and experiences of faculty responsible for teaching the dry needling content. The results from this study may be of value as an assessment tool for existing curricula within the framework of a program's educational philosophy and curricular plan. Additionally, the results may also be helpful for the development and facilitation of dry needling instruction in entry-level physical therapy education programs that do not currently address this content area.

Methods

This cross-sectional study explored the extent of dry needling instruction in entry-level education

programs for physical therapists in the United States through survey-based inquiry. In this study, dry needling was operationally defined as a skilled technique performed by a physical therapist using filiform needles to penetrate the skin and/or underlying tissues to affect change in body structures and functions for the evaluation and management of neuromusculoskeletal conditions, pain, movement impairments, and disability [13]. The framework for the survey paralleled a study evaluating physical therapy programs' status of manipulation education in entry-level education program for physical therapists' [15]. The 35-item survey collected information on (1) entry-level physical therapist program demographics, (2) descriptive information regarding dry needling instruction and curricula, and (3) faculty demographics, attitudes, and experiences. A preliminary version of the survey was reviewed for item clarity and content by four physical therapists who have expertise in dry needling techniques and survey-based research and their feedback was incorporated into the final draft of the survey (Appendix).

Invitations to complete the survey were sent via e-mail to the 226 directors of entry-level physical therapy programs recognized by the Commission on Accreditation in Physical Therapy Education. A letter of instruction was provided to each program director outlining the purpose of the study, the anonymous nature of the survey, and that participation was voluntary. The letter included a request to forward the e-mail to the primary faculty member responsible for teaching dry needling curricular content so that they may complete the survey, if indicated. They were also provided with a link to complete the survey through a web-based service (SurveyMonkey.com).

Prior to recruiting program directors to participate, the study was approved by the Human Subjects Research Review Committee at Daemen College, Amherst, NY, USA. Program directors were initially contacted in August 2017. A follow-up e-mail was sent two weeks after the initial invitation, requesting survey completion if it was not already submitted. Three weeks after the second request, one final attempt was made to contact non-respondents via e-mail. The final cutoff for completing the survey was 3 weeks after the final request.

For the surveys that were completed, the e-mail internet protocol address of the responding program was included in the response. Thus, non-responding programs were able to be identified; those programs that responded were not contacted for a follow-up e-mail. Follow-up e-mails were sent via an automated process through the same survey web-based service whereby the anonymity of those programs who had responded to date or not was maintained. Internet

protocol addresses were tracked in order to determine that each survey response represented a unique de-identified program while maintaining anonymity of responding program's data. Survey responses also could not be connected to a particular program even though an e-mail internet protocol address was entered into the survey response. More specifically, group data were only made available for analysis after the final cutoff date, and e-mail internet protocol addresses were located on a separate page of the survey responses that were de-coupled from the corresponding survey responses and not available during data analysis. Thus, there was no method to re-connect response data to the submitted e-mail.

Data analysis

Descriptive statistics were calculated in aggregate for survey data to determine the demographics of the entry-level physical therapy programs, the current status of dry needling instruction, and demographics of the faculty members responsible for instruction. Differences in demographic information between programs that did/did not include dry needling content in their curriculum were identified through the use of chi-square tests for categorical data and t tests for continuous data. The alpha level was set at $P < .05$.

Results

All e-mail internet protocol addresses for completed surveys were reviewed by the researchers and no duplicate internet protocol addresses were identified. These results, combined with the survey instructions stipulating that one response should be submitted per program, informs the postulate that each response received represented a unique program.

A total of 75 entry-level physical therapist programs responded to the survey (response rate = 33.1%). Program response rates by regional accreditation bodies were as follows: Southern Association of Colleges and Schools ($n = 27$, 36%), North Central Association of Colleges and Schools ($n = 22$, 29.3%), Middle States Association of Colleges and Schools ($n = 11$, 14.7%), New England Association of Schools and Colleges ($n = 7$, 9.3%), Western Association of Schools and Colleges ($n = 5$, 6.7%) and Northwest Commission on Colleges and Universities ($n = 3$, 4%). The majority of the programs ($n = 52$, 69.3%) were located in a state whose practice act allowed physical therapists to perform dry needling (Table 1). Of the 75 programs that responded to the survey, 40 (53.3%) had integrated dry needling theory and practice into their entry-level education programs. The proportion of programs that provided dry needling content was significantly greater for those programs located in a state

whose practice act allowed dry needling compared to those schools that were located in a state whose practice act did not include dry needling (82.5% versus 54.3%; $p = 0.004$). There was no significant difference for the length of the entry-level education program when comparing programs that provided dry needling content and those that did not (129.5 ± 18.6 versus 122.6 ± 16.9 weeks; $p = 0.07$).

Current status of dry needling instruction

Of the 40 respondents that had integrated dry needling theory and practice into their entry-level education programs, 8 did not provide any responses beyond question 6 of the survey; thus, the authors do not have any information about dry needling instruction from those schools. Of the remaining 32 respondents, 2 did not complete 5 questions (85% complete), 1 did not complete 3 questions (91% complete), and 2 did not complete 1 question (97% complete) pertaining to dry needling instruction from their schools. Twenty-seven respondents that had integrated dry needling theory and practice into their entry-level education programs completed all of the survey questions. All available data from these 32 responding programs who completed either all or part of the survey were used in our analysis.

The programs currently not teaching dry needling reported several reasons, including belief that it was not considered an entry-level skill ($n = 15$, 42.9%), not considered by the program to be a high enough curricular priority ($n = 13$, 37.1%), lack of qualified faculty ($n = 5$, 14.3%), not enough time available ($n = 5$, 14.3%), and perceived lack of scientific evidence regarding efficacy ($n = 5$, 14.3%). The majority of these programs that have not integrated dry needling had no plans to add dry needling to their current curriculum ($n = 22$, 62.9%); 8 programs (22.9%) planned to include such content in their curriculum in the future by either expanding a current course or developing a required elective course (Table 1).

Of the respondents that had integrated dry needling theory and psychomotor training into their entry-level education programs, most programs had integrated dry needling instruction into their curriculum in the previous 1–2 ($n = 13$, 32.5%) or 3–5 ($n = 16$, 40%) years. Twenty-eight (70%) programs indicated that dry needling education was integrated into a required course, 8 (20%) did not specify how dry needling education was integrated and 4 (10%) indicated that dry needling was an elective course. The mean reported estimate of dry needling contact hours was 2.9 ± 2.0 hours (range 1–8) for face-to-face classroom/lecture and 5.6 ± 11.7 hours (range 0–60) for laboratory experiences. When asked how much time should be available for instruction in dry needling, 19

Table 1. Program demographics, reasons for not teaching dry needling, and plans for implementation. *Respondents were able to check more than one response.

Length of Program (in weeks) (n = 75)	104 weeks or less	4 (5.3%)
	105–130 weeks	35 (46.7%)
	131–156 months	21 (28%)
	157 or more	3 (4%)
	Not answered	12 (16%)
1 st year cohort size (n = 75)	44.1 ± 13.2; range 24–80	
Does your state practice act allow PTs to perform dry needling? (n = 75)	Yes	49 (65.3%)
	No	22 (29.3%)
Program is located in more than one state and the practice act allows it in one state but not another	Not answered	3 (4.0%)
	Yes	1 (1.3%)
Have you integrated dry needling theory and practice into your entry-level Program? (n = 75)	No	40 (53.3%)
	Yes	35 (46.7%)
*Why is dry needling not in your Program? (n = 35)	Not considered as an entry-level skill	15 (42.9%)
	Not considered a high enough curricular priority	13 (37.1%)
	Lack of qualified faculty	5 (14.3%)
	Not enough time available	5 (14.3%)
	Lack of scientific evidence	5 (14.3%)
	Lack of financial resources	1 (2.9%)
	Other	15 (42.9%)
*Any plans to initiate/integrate dry needling into your current curriculum? (n = 35)	No plans to add to current curriculum	22 (62.9%)
	Expand a current course	3 (8.6%)
	Initiate a course	3 (8.6%)
	Initiate an elective course	2 (5.7%)
	Other	11 (31.4%)

(47.5%) programs replied that time available should remain as is, and 12 (30%) programs were in favor of more time. Most programs used a student:instructor ratio for dry needling laboratories of a 10:1 ratio or less (n = 11, 27.5%) or between 11:1 and 15:1 (n = 8, 20%). When comparing the student:instructor ratio for dry needling laboratories to other laboratories, most reported no difference in student:instructor ratio (n = 11, 27.5%) or a lower student:instructor ratio for dry needling skills (n = 8, 20%) (Table 2). Research papers were seen as the most valuable educational resource in teaching dry needling (Table 3).

With regard to percent instruction in dry needling by region, the most time was spent on the upper extremity peripheral joints (22.4 ± 15.1%; range 0–60%), followed by the lower extremity peripheral joints (20.9 ± 13.5%; range 0–50%) and the cervical spine (15.8 ± 16.2%; range 0–70%) and lumbar spine (13.2 ± 9.2%; range 0–30%) regions. Pistoning (n = 26, 83.9%), multiple needle (n = 14, 45.1%), multiple needle with electrical stimulation (n = 14, 45.1%), and twisting (n = 14, 45.1%) were the dry needling theories/principles that were most commonly taught. Student competency in dry needling was most commonly assessed through written examinations (n = 11, 27.5%). When asked to rate the level of competency of their program graduates to implement dry needling immediately upon graduation, 21 (52.5%) respondents rated their graduates as ‘not competent’ to implement dry needling into clinical practice, 5 (12.5%) rated their graduates as ‘minimally competent’, and 4 (10%) rated their graduates as ‘competent’ (Table 2). Those programs that rated their graduates as ‘competent’ or

‘minimally competent’ had a significantly greater number of contact hours for dry needling compared to the programs that rated their graduates as ‘not competent’ (face-to-face classroom/lecture: 4.9 ± 2.1 versus 2.1 ± 1.2 hours, p = 0.0001; laboratory experiences: 18.0 ± 16.4 versus 0.7 ± 0.8 hours, p < 0.0001). Increased use of dry needling during clinical internships and increased laboratory hours were the instructional methods that were thought to be most beneficial in influencing student knowledge and application of dry needling (Table 4).

Demographics of the faculty members responsible for instruction

Faculty demographic information revealed that 64.5% of the respondents were full- or part-time core faculty. The remainder of the faculty held either associated/adjunct faculty positions or were guest lecturers. The majority of the faculty reported that they had been teaching dry needling for 5 or more years (71.4%). Sixty-one percent of faculty had completed their entry-level training physical therapist degree greater than 11 years ago. Only 3 respondents reported receiving any entry-level education/training in dry needling; with regard to training in dry needling, the majority (n = 26, 65%) reported completion of coursework through established seminars or individual mentoring with an expert clinician (n = 14, 35%). When respondents were asked to rate their qualifications to teach dry needling, most considered themselves ‘well qualified’ (60.7%) or ‘moderately qualified’ (28.6%). Regarding the best way to increase the instructor’s

Table 2. Instructional methodologies, assessment techniques, and graduate competencies for programs teaching dry needling.
 *Respondents were able to check more than one response.

How is dry needling taught? (n = 40)	Integrated Content	28 (70%)
	Elective Course	4 (10%)
	Not answered	8 (20%)
How many years has dry needling been integrated into your program's curriculum? (n = 40)	1–2	13 (32.5%)
	3–5	16 (40%)
	>5	3 (7.5%)
	Not answered	8 (20%)
How many hours does your Program spend teaching dry needling theory and practice within each of these categories? (n = 32)	Face-to-face classroom/lecture	2.9 ± 2.0; range 1–8
	Laboratory	5.6 ± 11.7; range 0–60
	Patient assessment	3.1 ± 3.1; range 0–10
	Distance video instruction/demonstration	0
Percent instruction in dry needling by region. (n = 27)	Cervical spine	15.8 ± 16.2; range 0–70
	Temporomandibular joint	2.6 ± 3.2; range 0–10
	Thoracic spine	9.2 ± 11.5; range 0–25
	Upper extremity peripheral joints	22.4 ± 15.1; range 0–60
	Lumbar spine	13.2 ± 9.2; range 0–30
	Pelvis/Sacroiliac joint	8.4 ± 7.1; range 0–20
	Lower extremity peripheral joints	20.9 ± 13.5; range 0–50
*Which dry needling theories/principles are taught? (n = 31)	Pistoning	26 (83.9%)
	Multiple needle	14 (45.1%)
	Multiple needle with electrical stimulation	14 (45.1%)
	Twisting	14 (45.1%)
	Other	7 (22.6%)
What is your student:instructor ratio for dry needling laboratories? (n = 40)	10:1 ratio or less	11 (27.5%)
	Between 11:1 and 15:1	8 (20%)
	16:1 or greater	2 (5%)
	Not applicable as our Program does not have laboratory instruction of dry needling	11 (27.5%)
	Not answered	8 (20%)
What is your student:instructor ratio for dry needling laboratories compared to other laboratories? (n = 40)	No difference in student:instructor ratio	11 (27.5%)
	Higher student:instructor ratio for dry needling skills	2 (5%)
	Lower student:instructor ratio for dry needling skills	8 (20%)
	Not applicable as our Program does not have laboratory instruction of dry needling	11 (27.5%)
	Not answered	8 (20%)
*How is student competency in dry needling assessed? (n = 40)	Written examinations	11 (27.5%)
	Practical skill based techniques (lab competency checks)	3 (7.5%)
	Practical patient-based (real or simulated) examination	3 (7.5%)
	Clinical education	1 (2.5%)
	Student competency is not assessed	11 (27.5%)
	Not answered	11 (27.5%)
Level of competency for graduates of your Program to implement dry needling immediately upon graduation? (n = 40)	Not competent	21 (52.5%)
	Minimally competent	5 (12.5%)
	Competent	4 (10%)
	Not answered	10 (25%)
How much time should be available for instruction in dry needling? (n = 40)	More time	12 (30%)
	Remain as is	19 (47.5%)
	Less time	0 (0%)
	Not answered	9 (22.5%)

expertise related to teaching dry needling, clinical experiences with a mentor (74.2%) and continuing education (63.6%) were indicated as the most helpful.

All of the faculty respondents, except for 1, reported practicing in clinical settings, with most working between 1 and 10 (38.7%) and 31 or more (45.2%) hours. Half (50%) of the physical therapist faculty

respondents reported holding an academic doctorate, 20% had completed an American Board of Physical Therapy Residency and Fellowship Education accredited orthopedic/manual therapy residency, and 20% had completed an American Board of Physical Therapy Residency and Fellowship Education accredited orthopedic/manual therapy fellowship. Thirty-five (87.5%)

Table 3. Value of different resources in teaching dry needling (n = 40).

Resource	Do Not Use	Use; Not Valuable	Use; Somewhat Valuable	Use; Very Valuable	Did Not Answer
Text books	23 (57.5%)	1 (2.5%)	4 (10%)	1 (2.5%)	11 (27.5%)
Multimedia (CD/DVD)	23 (57.5%)	0 (0%)	4 (10%)	3 (7.5%)	10 (25%)
Research papers	3 (7.5%)	0 (0%)	11 (27.5%)	17 (42.5%)	9 (22.5%)
Other (e.g., 'apps', websites, etc.)	11 (27.5%)	2 (5%)	11 (27.5%)	5 (12.5%)	11 (27.5%)

Table 4. Different instructional methods and how each would impact student knowledge and application of dry needling (n = 40).

Instructional Method	Not Beneficial	Somewhat Beneficial	Very Beneficial	Did Not Answer
Increased lecture hours	7 (17.5%)	14 (35%)	6 (15%)	13 (32.5%)
Increased laboratory hours	3 (7.5%)	9 (22.5%)	15 (37.5%)	13 (32.5%)
Increased use of dry needling during clinical internships	2 (5%)	6 (15%)	19 (47.5%)	13 (32.5%)
Having a specialist teach the content	6 (15%)	7 (17.5%)	14 (35%)	13 (32.5%)

physical therapist faculty respondents reported holding an American Board of Physical Therapy Specialties clinical specialist certification (97.1% held certification in orthopedics or sports). Eight (25.8%) of the respondents reported being a Fellow of the American Academy of Orthopedic Manual Physical Therapists.

Discussion

While most of responding programs (53.3%) stated that dry needling was currently included in their curricula, the results of our study demonstrate some variability in the extent to which the content is integrated and what content is taught. For example, there was a wide range in the amount of lecture (range 1–8 hours) and laboratory (range 0–60 hours) content, as well as programmatic variability in the theories/principles taught and the time spent on different body regions. In particular, an average of 16% of time was spent on the cervical spine; however, the range was between 0 and 70% (Table 2), suggesting that while some programs did not include the cervical spine in their instruction, others spent a large majority of time on this region. These inconsistencies may be related to differences in training in dry needling for the faculty responsible for the content, as well as faculty experience and qualifications to teach dry needling.

As of 2006, the only program known that included course work in dry needling was the entry-level doctorate of physical therapy curriculum at Georgia State University [16]. Of the 75 programs that responded to our survey, 40 (53.3%) had integrated dry needling theory and practice into their entry-level education programs. Most programs had integrated dry needling instruction into their curriculum relatively recently (i.e., 72.5% of programs within the last 5 years). While the depth and breadth of the instruction varies, our results suggest that programs have made significant strides toward adding dry needling to the curricula of their

entry-level education programs for physical therapists. Nonetheless, the degree to which dry needling is an entry-level skill remains questionable. Of the programs that do not include dry needling in their curricula (n = 35), many believed it was not considered an entry-level skill (n = 15, 42.9%). Some noted that it was not considered by their program to be a high enough curricular priority (n = 13, 37.1%). Five programs (14.3%) cited a lack of scientific evidence for including dry needling content in their curriculum despite multiple systematic reviews concluding that dry needling is effective in decreasing pain and improving functional outcomes in patients with musculoskeletal disorders [3–12]. Also, the majority of these programs that have not integrated dry needling had no plans to add dry needling to their current curriculum (n = 22, 62.9%). These are interesting findings, given the dramatic increase in interest in dry needling in recent years, as seen by the number of certification programs, continuing education courses, and scientific publications on the topic.

The Federation of State Boards of Physical Therapy practice analysis of 2015 on dry needling reported that of the 116 entry-level and 22 needling-specific knowledge requirements, 117 were identified as important for competency in dry needling [14]. Of the 214 job tasks required of entry-level licensed physical therapists, 97 were judged to be relevant to dry needling. These tasks describe activities related to information gathering and system review (n = 17), testing and measurement (n = 33), evaluation and diagnosis (n = 11), prognosis and plan of care (n = 5), non-procedural interventions (n = 16) and patient/client and staff safety (n = 15). As related to dry needling specific tasks, nearly half (n = 12) of these tasks describe procedural actions such as positioning the patient, palpating the areas to be needled, needle handling, monitoring the patient, and disposing of medical waste. The remaining 14 tasks describe

activities related to information gathering, prognosis and plan of care, non-procedural interventions, and patient/client and staff safety.

The Federation of State Boards of Physical Therapy Task Force statement recommended sequencing with other procedural interventions and techniques (e.g., therapeutic exercises, neuromuscular reeducation, manual therapy, physical modalities) to augment therapeutic effects and minimize risk due to adverse outcomes and/or contraindications [14]. The Task Force also reported on how dry needling is integrated into practice. Our survey indicated that 28 (70%) programs indicated that dry needling education was integrated into a required course, 4 (10%) indicated that dry needling was an elective course, and 8 (20%) did not specify how dry needling education was integrated. Boissonnault et al [17], in their survey of physical therapy professional degree programs to determine the status of joint manipulation curricula, reported that 75% of joint manipulation instruction was part of a required integrated clinical science course. The integration of skills like dry needling and joint manipulation into clinical science courses allows for these skills to be discussed in the content of other recommended treatments and procedural interventions and techniques.

When asked to rate the level of competency of their program graduates to implement dry needling immediately upon graduation, 21 (52.5%) respondents rated their graduates as 'not competent' to implement dry needling into clinical practice, 5 (12.5%) rated their graduates as 'minimally competent', and 4 (10%) rated their graduates as 'competent' (Table 2). Interestingly, those programs that rated their graduates as 'competent' or 'minimally competent' had a significantly greater number of face-to-face classroom/lecture and laboratory hours compared to the programs that rated their graduates as 'not competent'. Further research is necessary to determine the optimal mode of dry needling content delivery to achieve 'competence', in terms of the optimal number of face-to-face classroom/lecture and laboratory hours, course type (i.e., required versus elective), and faculty experience/qualifications.

Faculty also believed that increased use of dry needling during clinical internships was the method that would be most beneficial in enhancing student knowledge and application of dry needling (Table 4). While increased emphasis of dry needling during clinical internships appears to be reasonable and pragmatic, there may be some potential challenges, including whether state practice acts allow dry needling, the knowledge and skill level of clinical instructors related to dry needling, and clinical instructors' attitudes toward the implementation of dry needling in physical therapist practice. Although it is beyond the scope of this paper, future research would be beneficial in describing clinical education opportunities for

students in dry needling and how those opportunities may influence competence.

There are several limitations that may have influenced the findings from this study. First, there was a 33% response rate to the survey. This response rate is lower than we expected for a non-incentivized survey [18]. Perhaps the design of the survey may have contributed to the lower response rate, as web-based surveys have some form of bias, such as underrepresentation of non-internet/social media users [19]. Nonetheless, the characteristics of those programs who responded to the survey might have differed from those who did not. Therefore, there may be concerns with the representativeness of the results. Second, while we requested that the survey be completed by the faculty member who was responsible for dry needling content, we are not exactly sure if this was done in all cases. This may call into question the accuracy of some of the information reported, especially if the individual who completed the survey was not the instructor responsible for dry needling content. Third, we had a relatively high rate of incomplete surveys submitted; for example, 13 of the 40 surveys were not fully completed, despite the fact that these respondents indicated that dry needling content was included in their curriculum. A possible reason for the large number of incomplete surveys was the potential perception that the survey questions were too time-consuming to easily complete in one sitting or for one person to easily complete. Another reason might be that the respondent did not have the information requested on the survey easily available or if they required consultation from another faculty member to complete the survey, they might have stopped the survey and neglected to complete it later. Fourth, there may have been some confusion regarding the wording of some of our survey items. For example, we described dry needling techniques (e.g., pistoning, multiple needle, twisting, etc.) as theories/principles. Additionally, when we asked about dry needling instruction for different body regions, some of our responses included 'joints' (e.g., upper extremity peripheral joints, lower extremity peripheral joints, temporomandibular joint), which may have been confusing for some of the respondents since dry needling is typically done to muscles or trigger points in muscles rather than joints. Despite these limitations, the findings from this study offer an initial representation of the status of dry needling education in entry-level education programs for physical therapists in the United States.

Conclusion

Of the 75 programs that responded to the survey, 40 programs had integrated dry needling theory and psychomotor training into their entry-level education programs and 8 programs planned to include such

content in their curriculum in the future. There appeared to be variability in how dry needling was integrated into the curricula, as well as in the depth and breadth of instruction. This variability in dry needling curricula suggests a need for the development of curricular guidelines and resources for physical therapist program instructors. Our research may serve as a baseline for faculty to assess existing dry needling curricula and as a guide for developing curricula in new or existing physical therapy programs.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

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