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REPORT



## Configuration variability of the six-minute walk test among licensed physical therapists working with neurologic conditions: a pilot survey

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### ABSTRACT

**Background:** The six-minute walk test (6MWT) is considered reliable and valid for assessing walking capacity in people with neurologic conditions. However, the consistency in the test length and configuration used is unclear.

**Purpose:** To determine how the 6MWT was configured by licensed physical therapists working with patients with neurologic conditions in clinical practice, identify their knowledge of the American Thoracic Society (ATS) and Academy of Neurologic Physical Therapy (ANPT) guidelines for the 6MWT and assess relationships between therapist demographic characteristics and knowledge of the 6MWT guidelines.

**Methods:** One hundred forty-six therapists completed a survey related to the configuration they used for the 6MWT.

**Results:** Configuration of the 6MWT varied widely. Space limitation was the most frequently selected reason for reported configurations. Over half had available the standardized 100-foot straight walkway but fewer than one-third used this configuration of the ATS guidelines. Fewer than half knew of the ATS guidelines and nearly three-fourths knew of the ANPT guidelines. American Physical Therapy Association membership and having a higher percentage of neurologic patients were associated with knowledge of both guidelines.

**Conclusion:** The 6MWT must be completed within the constraints of the working environment, and this requirement is clinically relevant when comparing patient results to normative values and measurements across clinics. Our results suggest a need for updated norms that are more congruent with space constraints in current practice settings.

### ARTICLE HISTORY

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### KEYWORDS

Walking capacity; 6MWT; six-minute walk test; guideline; configuration; outcome measure; neurologic conditions

### Introduction

Walking function is often reduced after neurologic injury or disease and becomes a key goal in neurorehabilitation. The six-minute walk test (6MWT) is a widely used clinical assessment tool that evaluates functional walking capacity. Although originally designed for and validated in individuals with cardiac or pulmonary disorders, the 6MWT has subsequently been validated in many patient populations, including those with neurologic conditions (Jackson et al., 2008; Lam, Noonan, and Eng, 2008; Moseley et al., 2004; Patterson et al., 2007; Quinn et al., 2013; Ries, Echternach, Nof, and Gagnon Blodgett, 2009; Sanjak et al., 2017; Steffen and Seney, 2008; van de Port, Wevers, and Kwakkel, 2011; van Hedel, Wirz, and Dietz, 2005). The results of the 6MWT provide clinical value when comparing patient status over time, can be related to the effectiveness of therapeutic intervention, and can help in determining patient functional mobility status when compared with normative values.

The length and configuration of the walkway used in the 6MWT can result in different outcomes (Almeida et al., 2019; Beekman et al., 2013; Dunn et al., 2015; Ng et al., 2011, 2013; Sandroff et al., 2014; Scieurba et al., 2003; Scivoletto et al., 2011). The American Thoracic Society (2002) published guidelines for the 6MWT recommending a 30-meter, or 100-foot, walkway in a corridor marked every 3 meters and with turnaround points marked by a cone. This configuration of the 6MWT was confirmed in 2014 to be valid, reliable, and sensitive to change with certain interventions in people with respiratory disease (Holland et al., 2014). The American Thoracic Society (ATS) guidelines have since been widely cited in the literature as the protocol used for the 6MWT in individuals with neurologic conditions. However, many rehabilitation clinics may lack a long walkway and therefore rely on shorter corridors for a back-and-forth walkway; large rooms for an oval, circular, rectangular, square, or figure-eight walkway of different dimensions; or even outdoor

walkways on sidewalks or in parking lots (Dunn et al., 2015). Although consistency of walkway configuration in the same clinic or location provides a degree of reliability results may not be comparable in different clinics or when compared with standardized values (Troosters, Gosselink, and Decramer, 2002). The configuration of the 6MWT has been shown to affect the overall distance walked in several populations including: individuals with neurologic conditions such as post-stroke (Dunn et al., 2015; Ng et al., 2011) and spinal cord injury (Scivoletto et al., 2011); older adults (Ng et al., 2013); and healthy adults aged 18 years and older (Almeida et al., 2019). No reports have focused on the effects of different configurations of the 6MWT in individuals with Parkinson's disease, traumatic brain injury, multiple sclerosis, Alzheimer's disease, or Huntington's disease.

The Academy of Neurologic Physical Therapy (ANPT) of the American Physical Therapy Association (APTA) recently published Clinical Practice Guidelines of a core set of outcome measures for adults with neurologic conditions undergoing rehabilitation (Moore et al., 2018). The 6MWT was included as one of these core measures, and its configuration was defined as a 12-meter  $\times$  1.24-meter rectangular walkway and based on the 6MWT configuration used in a multicenter study of 75 people with Huntington disease (Quinn et al., 2013) and similar to the configuration used by Mossberg (2003) and Mossberg and Fortini (2012) in their studies of people with traumatic brain injury. This recommendation of a 6MWT with a "clinic friendly" configuration is likely appreciated by clinicians in many clinical settings without access to a standardized 100-foot corridor. However, even with following these most recent recommendations of the ANPT Clinical Practice Guidelines clinicians will still be unable to use current reference values for comparison. Information is needed on the configurations, measurement methods (e.g. measuring wheel, calculating laps), and standard reference values being used by therapists working with patients with neurologic conditions. Therefore, the three aims of this study are to: 1) identify how and why physical therapists working with individuals with neurologic conditions configure the 6MWT in clinical practice; 2) identify the therapists' knowledge of the ATS and ANPT guidelines for the 6MWT; and 3) assess the relationships between therapist demographic characteristics and knowledge of the 6MWT guidelines.

## Methods

A survey was created for the current study following recommendations of Gehlbach and Artino (2018) for survey creation and using Qualtrics software. The survey items were created to gather information to address the study aims. The survey consisted of base questions designed as mostly yes or no responses. The skip logic function of Qualtrics was used to obtain more details for yes responses, which could increase the number of questions in the survey (Appendix). For example, one question asked "Do you administer the 6MWT test in your primary work setting?" If the therapist answered no, they progressed to the next question. If the respondent answered yes, skip logic directed them to a sub question that asked, "Do you use the same configuration to complete the 6MWT test for every administration?" If the answer was yes, the software continued to display additional sub questions to gather detailed information about the reasoning for the chosen configuration(s). The Qualtrics software provided only one survey question at a time. A response was required for each question to advance the survey to the next question. Survey questions asked respondents to describe characteristics of their 6MWT configuration, reasons for that configuration, and measurement and shape of the walkway at their primary clinic location. The same questions about test configuration were then repeated for secondary locations. Respondents' knowledge of the ATS guideline and ANPT clinical practice guideline for the 6MWT was also assessed by a yes or no response on the survey to gather information about their knowledge of the outcome measures. All questions had the same format with verbal labels, similar number of response options per question, and consistent presentation.

Questions that addressed our primary aims were placed at the beginning of the survey, and questions about demographic information were placed later in the survey to avoid influencing subsequent responses. Demographic questions asked whether respondents were licensed therapists or APTA members and about their years in clinical practice, percentage of patients on their caseload with neurologic conditions, and clinical practice locations (i.e. primary and if indicated, secondary clinic). The survey started with a page that provided information about the title and purpose of the study, the names of the researchers, the estimated time to complete

the anonymous survey (5 minutes), and study approval by the local institutional review board (#2019-146; determined to be exempt). This page also included an explanation of informed consent for participation in the study. By clicking on “Yes, I agree,” respondents provided their consent to participate and continued with the survey. If they did not consent, by clicking on “No, I do not agree,” the survey was ended.

### **Expert panel**

To establish content validity, an expert panel of licensed physical therapists who treat individuals with neurologic conditions pretested the survey in September 2019. The eight physical therapists were selected based on having previous knowledge of and experience with the 6MWT as an outcome measure and adequate understanding of research protocols and survey administration. They had two weeks to complete the survey, provide feedback to the primary investigators regarding its feasibility and ease of use, and suggest recommendations for improvement.

### **Pilot survey**

Following the panel’s feedback, the survey was edited to develop a pilot survey that included more detailed response options for configuration and practice setting questions and demographic age ranges according to those used in APTA national member surveys. Preset answers were added rather than open-ended text boxes to improve ease of analysis. For example, the question “*Please briefly describe the configuration/arrangement (dimensions) you use for administering the 6MWT test?*” was changed from an open text/open response box to structured responses to enhance the specificity of responses. Seven configuration options were provided, but an “other” choice was included for respondents who could not choose among the options. Additional skip logic was added to the survey to further query respondents who indicated they were knowledgeable about the updated ANPT clinical practice guidelines for the 6MWT and to determine whether they followed those configuration guidelines when administering the 6MWT (Appendix). The pilot survey was emailed to 117 neurologic physical therapists across the United States in October 2019. Potential respondents were personal and professional contacts of the study researchers and were given one month to complete the survey. Forty therapists completed the survey. The data were exported to SPSS statistical software version 26 (IBM Corp., Armonk, New York) and reviewed with the team statistician. No additional edits were deemed

necessary based on the presence of responses to all questions in all components of the survey.

### **National survey**

The finalized survey was distributed through state and national physical therapist professional media one month later. A brief explanation of the study and a link to the survey was published twice in January 2020 in the state physical therapy association electronic newsletter, and on the national ANPT listserv in January 2020. Included in the recruitment posting was the request to forward the survey link to other licensed therapist colleagues who worked with neurologic conditions and used the 6MWT, using a snowball recruitment method. The survey was open for two and a half months.

### **Statistical analysis**

Survey responses were summarized as frequencies and percentages. Percentages were calculated based on the number of responses for each question. Rank-biserial correlation coefficients were calculated according to Cohen (1988) to estimate the strength of the relationship between the percentage of patients with neurologic conditions and knowledge of 6MWT guidelines. Fisher’s exact tests were used to examine the relationships between categorical variables (i.e. configuration used, reason for using specified configuration, method of measurement, availability of 100-foot space, type of clinical setting, percentage of caseload with neurologic condition, years as practicing clinician, knowledge of ATS protocol, knowledge of ANPT guidelines, and APTA membership). An  $\alpha$  of 0.05, two-tailed, was used for statistical significance.

### **Results**

Overall, 146 respondents completed the survey: 40 for the pilot survey and 106 for the national survey. One person did not consent to participate. Because of the snowball distribution method, the number of potential participants was unknown, so we were unable to calculate a response rate. Demographic characteristics of respondents are presented in Table 1. Thirteen participants (8.9%) provided partial information, so totals do not always sum to 146.

### **Summary of demographic data**

Most of the survey respondents were APTA members (118, 90.1%), with a range of years in clinical practice recorded.

**Table 1.** Demographic characteristics of survey respondents (N = 146).

Characteristic	No. (%)
<i>Licensed PT</i>	
Yes	129 (98.5)
No	2 (1.5)
<i>APTA member</i>	
Yes	118 (90.1)
No	13 (9.9)
<i>Years in clinical practice</i>	
<1	4 (3.1)
1–3	18 (13.7)
4–5	12 (9.2)
6–10	24 (18.3)
11–15	24 (18.3)
16–20	9 (6.9)
21–30	26 (19.9)
31+	14 (10.7)
<i>Percentage of patients with neurological conditions</i>	
0	3 (2.3)
1–20	17 (13.0)
21–40	8 (6.1)
41–60	18 (13.7)
61–80	22 (16.8)
81–100	63 (48.1)
<i>Patients with Parkinson disease seen each week</i>	
0	45 (34.4)
1–3	56 (42.8)
4–6	17 (13.0)
7–9	3 (2.3)
10+	10 (7.6)
<i>Primary work setting</i>	
Academic institution	31 (20.2)
Acute care hospital	11 (7.2)
Health and wellness facility	2 (1.3)
Hospital-based outpatient facility or clinic	46 (30.0)
Industry	1 (0.7)
Inpatient rehabilitation facility	19 (12.4)
Patient's home/home care	2 (1.3)
Private outpatient office or group practice	26 (17.0)
Research center	9 (5.9)
School system (preschool/primary/secondary)	0 (0)
Skilled nursing facility/long-term care	2 (1.3)
Other	4 (2.6)
<i>Secondary work setting</i>	
Academic institution	10 (13.0)
Acute care hospital	10 (13.0)
Health and wellness facility	2 (2.6)
Hospital-based outpatient facility or clinic	14 (18.2)
Industry	1 (1.3)
Inpatient rehabilitation facility	13 (16.9)
Patient's home/home care	7 (9.1)
Private outpatient office or group practice	8 (10.4)
Research center	4 (5.2)
School system (preschool/primary/secondary)	3 (3.9)
Skilled nursing facility/long-term care	4 (5.2)
Other	1 (1.3)

Some participants provided partial information, so totals may not always add to 146. Percentages may not total 100% because of rounding; APTA, American Physical Therapy Association; PT, physical therapist.

Almost half of the respondents (62, 49.1%) reported a high neurological caseload of 81–100%. Respondents' primary place of employment was approximately one-third in hospital or outpatient facility or clinic (40, 30.0%) while other

common places of primary employment tended to be academic institutions (31, 20.2%) and private outpatient office or group (26, 17.0%) (Table 1). Our study sample had similar demographic representation but had twice the



respondents practicing in academic institutions and inpatient rehab facilities and half the respondents in private practice than the APTA survey respondents.

### Performed the 6MWT test in their primary work setting

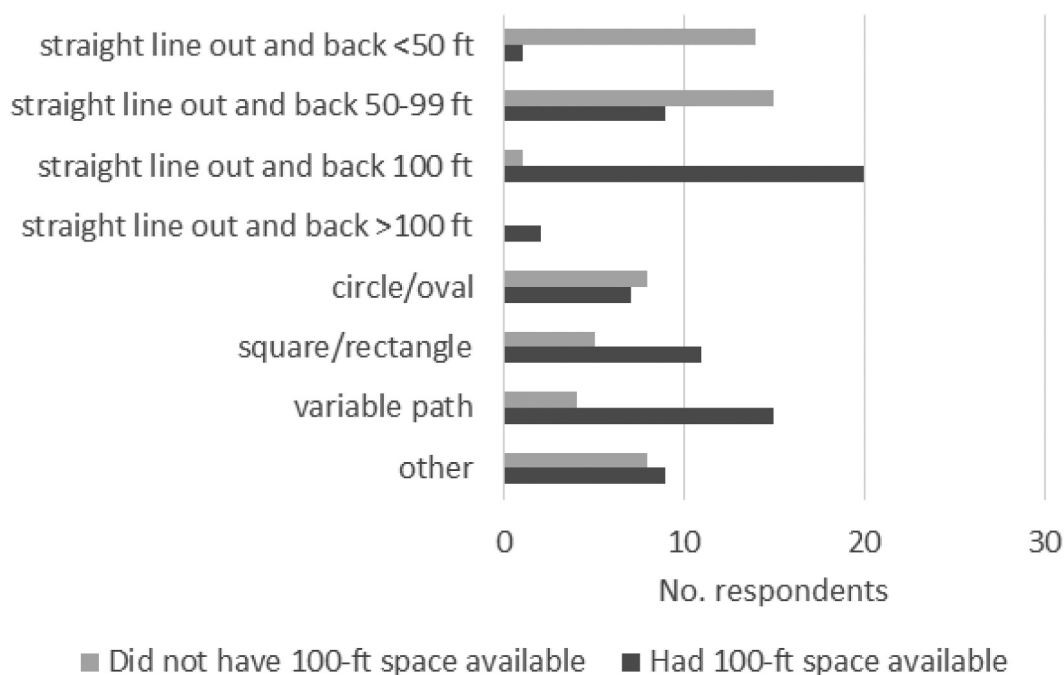
Of the 146 therapists who responded to the survey, 136 (95.1%) reported that they performed the 6MWT in their primary work setting (Table 2). Among those, 106 (77.9%) used the same configuration for every

administration, and 134 (91.7%) described their configuration. Twenty-one (15.7%) used a 100-foot straight line out and back configuration, 42 (31.3%) a straight line out and back configuration that was not 100 feet, 15 (11.2%) a circular configuration, 17 (12.7%) a rectangular configuration, 22 (16.4%) a variable configuration, and 17 (12.7%) an “other” configuration (Figure 1). Respondents were asked to describe the exact dimensions of the configurations used other than straight line out and back, and 49 different configurations were described (Table 3).

**Table 2.** Survey results by question (N = 146).

Survey Question	No. (%)
<i>Do you administer the 6MWT in your primary work setting?</i>	
Yes	136 (95.1)
No	7 (4.9)
<i>Do you use the same configuration to complete the 6MWT for every administration?</i>	
Yes	106 (77.9)
No	30 (22.1)
<i>Please briefly describe your configuration you use for administering the 6MWT</i>	
Straight line out and back <50 ft	16 (11.9)
Straight line out and back 50–99 ft	24 (17.9)
Straight line out and back 100 ft	21 (15.7)
Straight line out and back >100 ft	2 (1.5)
Circle/oval	15 (11.2)
Square/rectangle	17 (12.7)
Path is variable	22 (16.4)
Other	17 (12.7)
<i>Please explain why you use this configuration/arrangement</i>	
Space available	99 (42.9)
Clinic is crowded	42 (18.2)
Following clinic protocol (preset distance)	32 (13.9)
Trained to complete it this way	14 (6.1)
Following evidence-based guidelines	29 (12.6)
Other	15 (6.5)
<i>How do you measure the distance walked?</i>	
Following with a measuring wheel	68 (47.6)
Calculate/count laps based on a preset distance	62 (43.4)
Other	13 (9.1)
<i>Does your work environment have an open walking space measuring 100 ft long?</i>	
Yes	80 (59.7)
No	54 (40.3)
<i>Do you administer the 6MWT in any other work settings?</i>	
Yes	32 (24.1)
No	101 (75.9)
<i>Briefly discuss the configuration you use to administer the 6MWT in this secondary setting</i>	
Straight line out and back <50 ft	0 (0)
Straight line out and back 50–99 ft	5 (15.6)
Straight line out and back 100 ft	9 (28.1)
Straight line out and back >100 ft	0 (0)
Circle/oval	8 (25.0)
Square/rectangle	3 (9.4)
Path is variable	3 (9.4)
Other	4 (12.5)
<i>Please explain why you use this configuration?</i>	
Space available	22 (40.7)
Clinic is crowded	3 (5.6)
Following clinic protocol (preset distance)	9 (16.7)
Trained to complete it this way	5 (9.3)
Following evidence-based guidelines	10 (18.5)
Other	5 (9.3)
<i>How do you measure the distance walked?</i>	
Following with a measuring wheel	15 (42.9)
Calculate/count laps based on a preset distance	18 (51.4)
Other	2 (5.7)

Some participants provided partial information, so totals may not always add to 146. Percentages may not total 100% because of rounding. 6MWT, six-minute walk test; Q, question.



**Figure 1.** Configurations of the six-minute walk test (6MWT) used by survey respondents who did or did not have a 100-foot walkway available.

### **Space available and reasons for configuration used**

While 80 (59.7%) respondents reported that their facility had an open walking space at least 100 feet long, only 20 (27.0%) of them used the 100-foot straight line out and back configuration (Figure 1). However, available space was the most frequently selected reason (99, 42.9%) for reported configurations (Table 2). The next most frequently reported reasons for configurations used were that the clinic was crowded (42, 18.2%) and they were following clinic protocol (32, 13.9%) or evidence-based guidelines (29, 12.6%). Other reasons volunteered for the reported configurations included convenience, patient tolerance, and maximal speed with minimal turning (Table 4). The discrepancy between those who had 100 feet of space available in the clinic (80) and those who used it (20) highlights that, despite having room, other factors can take precedence over the standardized configuration when performing the 6MWT.

### **Completed the 6MWT test in their secondary work setting**

Of 133 respondents (13 did not respond to this item), 32 (24.1%) reported they administered the 6MWT in another work setting (Table 2). Among these, the majority used the 100-foot straight line out and back configuration (9, 28.1%) or a circle/oval configuration (8, 25.0%). Other responses and configurations are listed in Table 2. The most common reason for reported

configurations as with their primary work setting was available space (22, 40.7%).

### **Measurement method of the distance walked**

The methods of measuring distance were primarily completed through one of two techniques: including following with a measuring wheel (48%) or counting laps based on a preset distance (43%). In the primary setting, most respondents measured the distance their patients walked by following with a measuring wheel (68, 47.6%) or calculating/counting the number of laps based on a preset distance (62, 43.4%) (Table 2). Written responses for other measurement methods are reported in Table 5. Results were similar in secondary settings (Table 2).

### **Knowledge of ATS and ANPT guidelines and work site**

Of the 146 survey respondents, less than half (61, 46.2%) indicated that they knew about the ATS guidelines for the 6MWT (Table 2). However, the majority (95, 72.5%) were aware of the ANPT clinical practice guidelines for the 6MWT. This may explain why so few (15%) of respondents who performed the 6MWT in their primary clinic setting used the 100-foot straight line out and back standardized configuration of the ATS guidelines. Among those who indicated knowledge of the ATS guidelines, 20 (32.8%) listed their primary work site as an academic institution

**Table 3.** Written descriptions of exact dimensions used for the 6MWT in primary and secondary work settings.

Description	No. Responses
<i>Primary work setting (n = 58)</i>	
10-m walkway	1
20 meters or 30 meters	1
25 meters out and back	1
35-ft × 65-ft rectangle	1
50-ft long path with 25-ft marker in the middle	1
Either 50 ft out and back with chair or straight path around <300 ft for higher level patients	1
50-ft walkway with 90-degree turn × 3 then 180-degree turn to repeat	1
60-meters straight line out and back	1
90 × 30	1
100-ft circular path around gym or 350 ft in hallways	1
100 ft out and back	2
108-ft oval	1
120-ft square (30 ft each side)	1
120-ft oval track	1
120-ft rectangle	1
120-ft lap	1
140-ft circular path	1
150 ft	2
150 ft × 4 hallways	1
155-ft oval track	1
180-ft × 30-ft rectangle	1
228-ft square/perimeter (57 ft each side)	1
250 ft	1
280-ft oval	1
300-ft loop	1
300-ft lap shaped like a triangle	1
300-ft lap around nurse's station	1
Varies 300-ft loop or 150-ft loop depending on availability	1
310 ft	1
325-ft perimeter rectangle	1
486-ft square in building	1
Walks out 500 ft with 1 left turn and then comes back (repeat)	1
550-ft rectangle (90-degree turns)	1
600-ft lap around unit	1
610-ft circle around units	1
610-ft track with various shortcuts, patient chooses path	1
1000-ft outside sidewalk	1
1200-ft hallway	1
Hallway of facility	5
Patient choice: walk anywhere and measure using a measuring wheel	3
We do not have a set space to use consistently; therapists have decided to use a variable path as long as it incorporates turns.	1
Either circle in gym or long hallway depending on function of patient	1
Around the building	1
Per ATS guidelines: 20- or 25-m length between 2 cones	1
12-meter path per CPG recommendations	2
Use a loop with a bunch of left turns	1
Straight away, with a left turn, straight away and then back	1
L-shaped path with 100 ft on both segments	1
L shape	1
<i>Secondary work setting (n = 13)</i>	
50–100 ft path	2
60 ft in an oval path	1
80 ft, 40 ft, 85 ft, 30 ft approximate rectangle	1
95 ft × 170 ft	1
100-ft lap	1
100-ft square approximately around nurse's station in ICU	1
200-ft oval	1
300-ft hallway in SNF	1
1000-ft sidewalk outside	1
Outdoors on pavement around building	1
Walking on various surfaces/outdoors depending on patient's functional limitations and discharge anticipation	1
Unsure/walk laps around PT gym area that is a square	1

Written responses have been edited slightly for consistency and clarity. Abbreviations: 6MWT, six-minute walk test; ATS, American Thoracic Society; CPG, Clinical Practice Guidelines; ICU, intensive care unit; PT, physical therapy; SNF, skilled nursing facility.



**Table 4.** Written explanations from “other” responses for use of a specific 6MWT configuration.

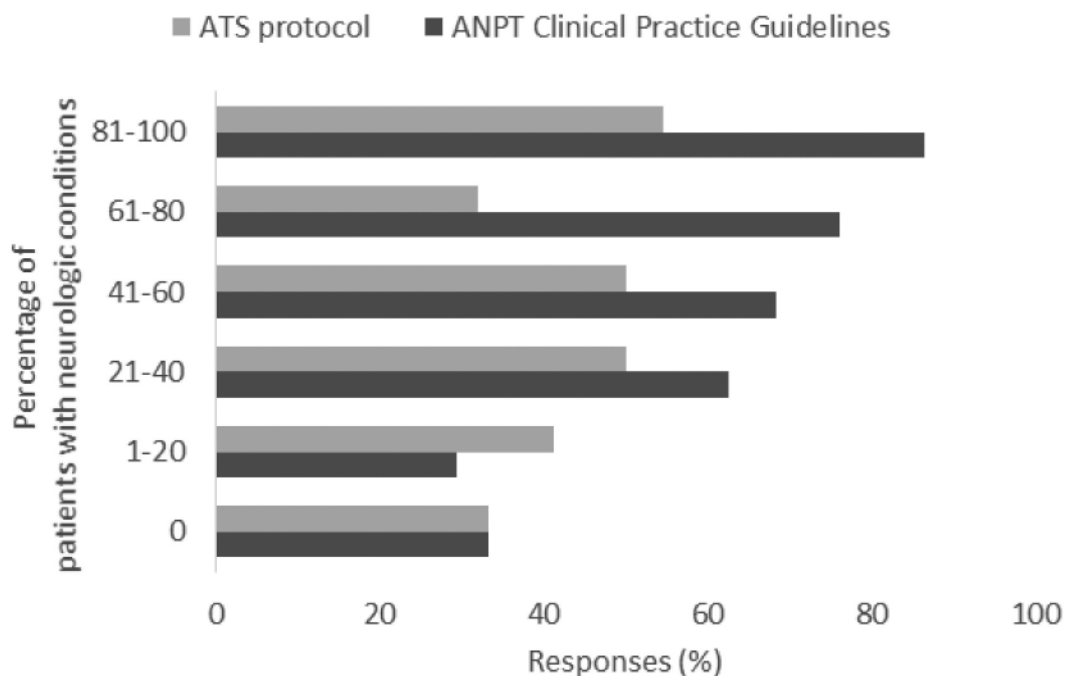
Explanation	No. responses
I am a research PT and administer assessment for multiple studies and follow the individual PT's protocols	1
Use hospital hall that is less crowded	1
Using iWalk Assess App	1
It makes more sense to me to walk in a functional manner than artificially incorporating turns every so many feet. I realize it would need to be more standardized for research purposes but on a gross level appears to reflect functional progress.	1
It's easy to use as it's just 4 long hallways	1
In a hospital inpatient setting on different floors	1
To allow for maximal speed with minimal turning	1
Depends on space in the facility and patient tolerance	1
I use this that way – I have the same route every time	1
Convenience, no preset course	1
The original ATS guidelines 25 meters	1

Written responses have been edited slightly for consistency and clarity. Abbreviations: 6MWT, six-minute walk test; ATS, American Thoracic Society; PT, physical therapist.

**Table 5.** Written explanations from “other” responses for method of measurement for distance walked during 6MWT.

Measurement method	No. responses
Combination of measuring wheel and counting laps	2
Use wheel to measure last lap or when not completed lap	2
Count floor tiles	2
Present distance plus 10-ft hash marks on the floor	1
Use measuring wheel or tape measure for part of lap	1
Measure and count ceiling tiles	1
25-ft lines already marked on the floor	1

Written responses have been edited slightly for consistency and clarity. Abbreviation: 6MWT, six-minute walk test.

**Figure 2.** Percentage of physical therapists with knowledge of the American Thoracic Society (ATS) protocol or Academy of Neurologic Physical Therapy (ANPT) Clinical Practice Guidelines for performing the six-minute walk test (6MWT) by percentage of patients with neurologic conditions.

and 20 (32.8%) listed a hospital-based outpatient facility or clinic. Similarly, of those who indicated knowledge of the ANPT clinical practice guidelines, 27 (28.4%) listed their primary work site as an academic institution and 33 (34.7%) listed a hospital-based outpatient facility or clinic.

### **Correlations with percentage of patients with neurologic conditions**

The most commonly reported percentage of therapists working with patients with neurologic conditions was 81–100% (63, 48.1%) (Table 1 and Figure 2). The percentage of patients with neurologic conditions on a therapists' caseload was moderately and positively correlated with knowledge of the ANPT clinical practice guidelines ( $r_{rb} = 0.39$ ,  $P < .001$ ), but not the ATS guidelines ( $r_{rb} = 0.11$ ,  $P = .21$ ) (Figure 2). In other words, the greater their neurologic caseloads, the more therapists tended to know of the ANPT clinical practice guidelines (Figure 2). The survey question did not specify a time window for this caseload estimation.

### **Comparisons between knowledge of 6MWT guidelines and demographic characteristics**

The distribution of respondents' years in clinical practice fell mostly in the 6–15 year mid-career range (48, 36.6%) (Table 1) with no indication of the more experienced clinician using any particular configuration. Number of years of clinical practice was not associated with the configuration used when administering the 6MWT, knowledge of the ATS guidelines, or knowledge of the ANPT clinical practice guidelines (all  $P > .05$ ).

Of the 131 respondents who answered the APTA member question, 118 (90.1%) were APTA members and 13 (9.9%) were not (Table 1). The APTA members (59, 50.4%) were more likely to know about the ATS protocol than those who were not members (1, 7.7%,  $P = .003$ ). However, APTA members (86, 72.9%) were no more likely to know about the ANPT clinical practice guidelines than those who were not members (9, 69.2%,  $P = .75$ ). The data for the configuration used when administering the 6MWT according to APTA membership status were too sparse to evaluate inferentially (only 13 non-APTA members and seven configurations), but the most common protocol used by both groups was the straight line out and back at 50–99 feet (21, 18.8% for APTA members and 3, 23.1% for non-APTA members).

## **Discussion**

The central findings of this survey study are that physical therapists working with individuals with neurologic conditions often used the 6MWT, a measure of walking capacity. Over half of respondents had 100-feet of walkway available in their clinical work settings, but fewer than one-third administered the test using the standardized configuration of the ATS guidelines of 100-feet straight line out and back. In fact, only a fraction of all respondents (15%) using the 6MWT configured according to the ATS guidelines. The remainder of respondents used a stunningly wide variety of other configurations of which 49 were described. Despite this variety, over three-quarters of respondents used the same configuration consistently, implying that the within-therapist and within-clinic consistency of outcome measure was largely maintained and that the selection of configuration of 6MWT is not diagnosis dependent.

Consistency of measures within-patient and across-clinics is crucial for comparing an individual's status over time or when they are seen in different clinics. Test consistency also provides insight into the effectiveness of therapeutic interventions, and aids in determining patient functional status and prognosis when compared to published normative values for standardized outcome measures. The total distance walked and minute-by-minute changes in walking speed during the 6MWT can be strong predictors of community-based walking activity for stroke survivors (Awad, Reisman, and Binder-Macleod, 2019; Fulk, He, Boyne, and Dunning, 2017; Fulk, Reynolds, Mondal, and Deutsch, 2010). The clinical utility of the 6MWT is heavily reliant on consistent and standardized administration procedures, particularly configuration (Barnett et al., 2016; Troosters, Gosselink, and Decramer, 2002). Resource databases of such normative values across many patient populations and disease conditions are available for therapists to use when assessing patient outcomes (<https://www.sralab.org/rehabilitation-measures/6-minute-walk-test>). The variation of configurations with over 50 described or selected by our respondents in administration of the 6MWT is consistent with other studies. A review and meta-analysis of studies using the 6MWT with stroke survivors found that only 9 of 127 studies reported using a 30-meter walkway (Dunn et al., 2015). Most of the reviewed studies lacked any description of the configuration and 38 studies described using shorter (10 to <30 meters), longer (>30–85 meters), and continuous walkways which included oval and rectangular configurations (Dunn et al., 2015). Similar results were found in

a review of 24 studies that used the 6MWT in low-resource settings reporting that 88% used a configuration that differed from the standard 100-foot/30-meter straight walkway of the ATS guidelines (Fell, Hanekom, and Heine, 2021). In their letter to the editor regarding the article on the 6MWT in community-dwelling elderly by Steffen, Hacker, and Mollinger (2002); Troosters, Gosselink, and Decramer (2002) highlighted the importance of standardization of the 6MWT to elevate the fidelity of comparisons. The authors specifically noted differences in distance completed given variations in patient height, encouragement provided, and practice effect. Although they did not directly discuss configuration, they recommended standardized performance of the 6MWT so results could be used in a meaningful way (Troosters, Gosselink, and Decramer, 2002). Factors other than the configuration used for the 6MWT also influence test results including method of measurement (i.e. measuring wheel and mathematical calculations), instructions or encouragement, environment (i.e. outside, treadmill), age, weight, and body mass index (Dunn et al., 2015; Fell, Hanekom, and Heine, 2021, 2022; Joobeur et al., 2016; O'Neal et al., 2022). When determining the distance walked in three different configurations of the 6MWT: 1) ATS guidelines; 2) ANPT guidelines; and 3) a 12-meter straight out and back use of a measuring wheel inflated the test results in all 3 configurations, with the least discrepancy found in the configuration of the ATS guidelines (O'Neal et al., 2022). Although important for overall consistency and test standardization, information on these other factors was not collected and not the focus of this study.

The primary reason given by respondents for using a configuration other than that of the ATS guidelines given in our study was limited available space. Space constraint resulting from environmental conditions was also the most common reason found in the literature for using configurations other than a straight 30 meters and more often no reason was reported for the change in configuration (Dunn et al., 2015; Fell, Hanekom, and Heine, 2021). Considering ours and others' findings of space limitations by clinical practitioners, validation and standardization of other test configurations is imperative to assure test fidelity and clinical usefulness. Other rationale given by respondents of the current study may have taken precedence over choosing the 30-meter straight configuration of the ATS guidelines such as: convenience because they were using space that was less crowded; using measuring apps; allowing for maximal speed with minimal turns; or mimicking everyday walking situations with irregularly spaced turns. The number and degree of turns in the

configuration is a clear factor in performance of the 6MWT particularly for individuals with neurologic conditions who have difficulty with turns such as: stroke; spinal cord injury, Parkinson's disease (PD), multiple sclerosis (MS), and Huntington's disease (HD) (McIsaac et al., 2019; Ng et al., 2011; Quinn et al., 2013; Sandroff et al., 2014; Scivoletto et al., 2011). The differences between the configurations of the ATS and ANPT guidelines for the 6MWT are quite pronounced. The ATS guideline uses a 30-meter straight out and back distance with 180 degree turns, and the ANPT guidelines use a 12-meter  $\times$  1.24-meter rectangle with 90 degrees turns around four cones. For clinicians working largely with people with neurologic conditions, knowing the effects of using different configurations of the 6MWT that require different numbers and degrees of turning is imperative.

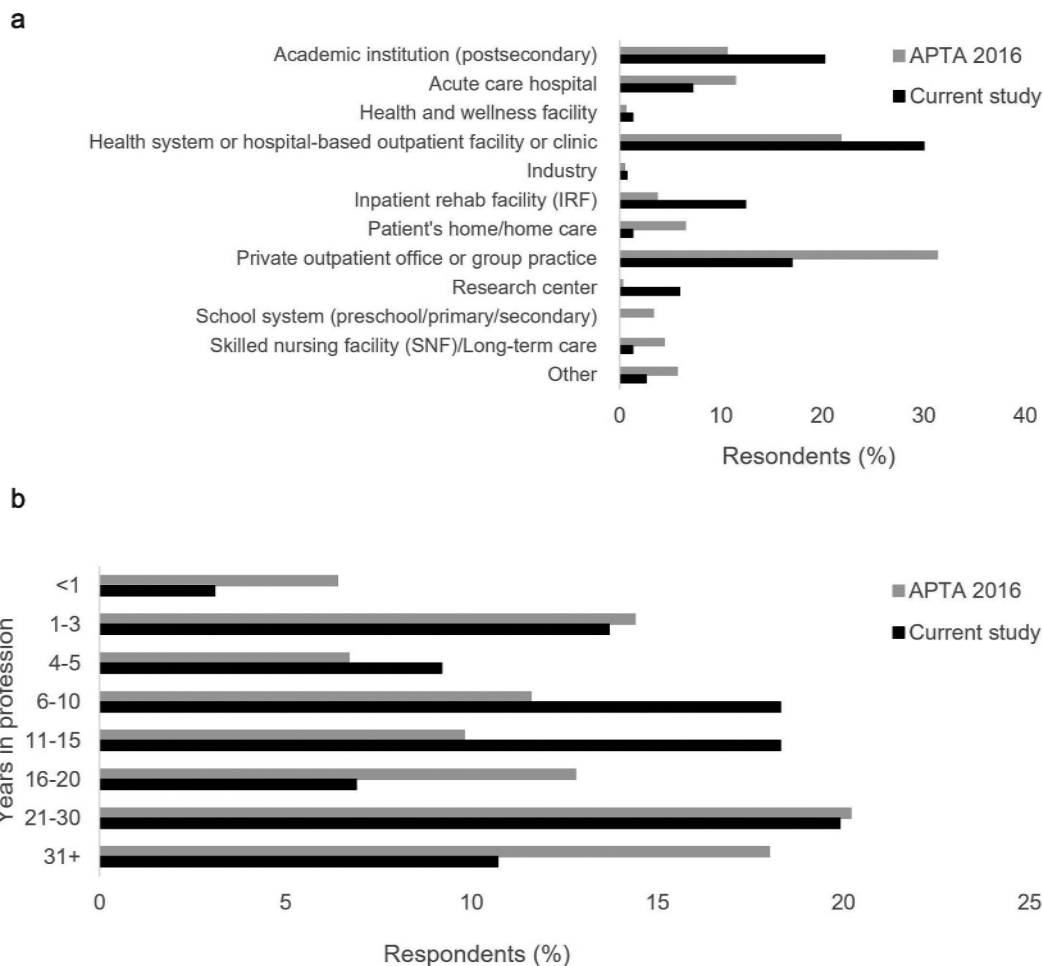
Turning performance in people with neurodegenerative disease (i.e. PD, MS, and HD) can be an important marker of balance and gait, disease classification and progression, and response to therapeutic treatment, including medication (Adusumilli et al., 2018; Purcell et al., 2020; Rehman et al., 2020). In a previous study in Parkinson disease the difference in distance walked on a 25-foot out and back configuration was on average 63 meters shorter than the standard 100-foot configuration. Importantly, a subgroup of participants ( $n = 11$ ) with freezing of gait (FOG) walked 72 meters less in the 25-foot configuration than in the 100-foot configuration (McIsaac et al., 2019) nearly reaching the minimal detectable change (MDC) of 82 meters (Steffen and Seney, 2008). The authors attributed the decline in distance to the increased number of turns required on the 25-foot course (McIsaac et al., 2019). For those with FOG, the increased number of turns may also cause increased episodes of freezing (Spildooren et al., 2010) which may further decrease their distance. Inconsistencies in the 6MWT configurations with variation in turning requirements from one clinic to another or between clinicians according to their preferred configuration could significantly reduce the clinical utility of the test.

Studies of individuals post stroke, spinal cord injury, and older adults have also shown the impact of different configurations of the 6MWT on overall distance covered. Ng et al. (2011) compared the 6MWT distance of individuals with chronic stroke on a 10-meter (~33 foot), 20-meter (~66 foot), and 30-meter (~100 foot) walkway. On average, participants walked 29 meters less in the 10-meter configuration than in the 30-meter configuration, which was slightly under the MDC of 36 meters for chronic stroke (Flansbjerg et al., 2005). Similarly, in

healthy older adults, participants walked nearly 70 meters less in the 10-meter than in 30-meter configuration (Ng et al., 2013) which was well over the MDC of 58 meters for older adults (Perera, Mody, Woodman, and Studenski, 2006). In people with incomplete spinal cord injury, Scivoletto et al. (2011) found participants walked 39 meters less in the 10-meter than in the 50-meter configuration, nearly reaching the MDC of 45.8 meters. In adults with multiple co-morbidities, Fell, Hanekom, and Heine (2022) found that the 6MWT difference between the 10-meter and the 30-meter straight out and back configurations was 67 meters and increased to 77 meters of difference between the 30-meter straight out and back and a 10-meter long figure-of-8 configuration. Thus, using different configurations of the 6MWT may result in values that are incorrectly interpreted as clinically significant improvement or decline. The recent review by Fell, Hanekom, and Heine (2021) supports this conclusion determining that using various forms of the

6MWT can lead to an underestimation of the patient’s actual abilities or an overestimation of their progress.

Knowledge of 6MWT protocols, specifically of configurations, could be another factor besides space available to explain that only a fraction of survey respondents in our study used the configurations of the standardized, valid, and reliable ATS guidelines. One might reason that the configuration published sixteen years earlier with validity and reliability of the protocol available would be the configuration more commonly used. For those respondents in the current study who indicated they used the 6MWT in primary and secondary work settings, fewer than half were knowledgeable about the standardized configuration protocol described by the ATS guidelines published in 2002. Conversely, almost three-fourths were familiar with the configuration from the ANPT clinical practice guidelines published only two years prior to our survey. One factor for respondents having knowledge of the ANPT and ATS guidelines for the 6MWT might be related to membership in



**Figure 3.** Comparison of current study respondents with the American Physical Therapy Association (APTA) most recent available data on member demographics from 2016. (a) Percent respondents by practice setting. (b) Percent respondents by years.



the APTA and access to resources. This is supported by the finding that our respondents who were APTA members were more likely to know about the ATS protocol configuration than non-APTA members, suggesting that membership in the professional association may increase knowledge of evidence-based publications and use of standardized outcomes in clinical practice. The ANPT is an academy within the APTA that is focused on neurologic physical therapy and has an official journal within which the ANPT clinical practice guidelines for the 6MWT appeared (Moore et al., 2018). This may explain why more respondents were aware of the ANPT than the ATS guidelines for the 6MWT configuration. These results, however, should be considered with caution considering the vast majority of our respondents were APTA members and we were unable to run comparative analyses based on membership.

Although the survey of the current study was distributed nationally, the number of physical therapists who responded was small relative to the approximately 223,000 licensed physical therapists in the United States (American Physical Therapy Association, 2020a). We compared the demographics of our sample with the demographics of licensed physical therapists according to the most recent available data from the APTA survey in 2016 (Figure 3) (American Physical Therapy Association, 2020b). One might expect clinicians in an academic institution and a hospital or health system-based setting to have greater resources for evidence-based practice information due to the larger library and database subscriptions, compared with private outpatient office settings. Likewise, APTA members have access to resources and literature that are less available to nonmembers. As 90% of our survey respondents were APTA members, this may have resulted in our respondents having more knowledge of the ATS and ANPT guidelines than all the licensed therapists represented in the APTA 2016 demographics. One might therefore expect that our sample would have greater consistency in using the standardized 6MWT configuration of the ATS guidelines. While most of our study respondents reported configuring the 6MWT consistently and nearly half with knowledge of ATS guidelines, these may be inflated compared to the general population of therapists. We anticipate that surveying a larger number of therapists would result in even less consistent administration and standardization of configuration of the 6MWT than shown here.

Numerous studies comparing different configurations of the 6MWT, most being different lengths of straight walkways, have reported different outcomes across configurations, as reviewed in the Introduction. The results from our study indicate a need for updated norms that are more congruent with space constraints in current practice

settings. Additional research should be conducted to develop predictive models of using different configurations of the 6MWT, specifically in different neurologic populations, since some patient populations may benefit from different types or shapes of walkways. For example, to improve ease of testing and accommodate the choreic gait of their participants with Huntington disease Quinn et al. (2013) chose the rectangle-shaped configuration with 90-degree turns that was later adopted in the ANPT clinical practice guidelines as a modification of the standard 100-foot configuration of the 6MWT. Perhaps, individuals with PD who experience FOG may perform better on an oval or circular walking course where turning is eliminated altogether. Furthermore, individuals with balance concerns (i.e. vestibular hypofunction, ataxia, or stroke) may benefit from a 6MWT configuration that involves only a curved or winding walkway without sharp turns. Therefore, for optimum performance, different patient populations may benefit from different configurations of the 6MWT, and this should be explored in future research.

Future studies should include investigation of configurations of the 6MWT other than the 30-meter (100-foot) standard of the ATS guidelines with several patient populations and medical conditions. Larger studies with more therapists across numerous clinical practice settings will provide more robust results. Future studies could establish a prediction equation that includes the effects of different course sizes or configurations, tested specifically in participants with neurologic conditions, similar to the predictive models recently developed in the young adult population by Almeida et al. (2019).

## Conclusions

Results of this small and focused survey suggest that greater effort may be needed to educate physical therapists working with patients with neurologic conditions who administer the 6MWT about the standardized protocol published by ATS in 2002. The large inconsistency of 6MWT configurations we found among our respondents across practice settings suggests that the test outcome may not be comparable with published normative values or reliable for interpreting clinically meaningful change with intervention, as the result of degenerative disorders, or in identifying disease course or stage. Therefore, we recommend the use of consistent within-clinic and within patient configurations that are well documented to support within-patient changes in function. We also suggest the need for additional studies to validate configurations in addition to the ATS configuration guidelines and to develop predictive models that include different-sized courses and configurations of the 6MWT for patients with neurologic conditions.

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## Appendix – 6MWT Survey

Q16 Welcome! The purpose of this survey is to determine how licensed physical therapists administer the six-minute walk test (6MWT) in clinical settings and the reason behind the reported configuration(s). Please understand this survey is intended for licensed physical therapists. By clicking the button below, you acknowledge that your participation in the study is completely voluntary and that you are aware you may terminate your participation at any time. Please answer honestly as this is an anonymous survey. The survey will take approximately 5 minutes to complete. Thank you for your time. A.T. Still University IRB Protocol # 2019-146

- I consent, begin the survey
- I do not consent, I do not wish to participate

*Skip To: End of Survey If Q16 = I do not consent, I do not wish to participate*

Q1 Do you administer the 6-Minute Walk test in your primary work setting?

- Yes
- No

*Display This Question: If Q1 = Yes*

Q18 Do you use the same configuration to complete the 6-Minute Walk Test for every administration?

- Yes
- No

*Display This Question: If Q1 = Yes*

Q2 Please briefly describe the configuration/arrangement (dimensions) you use for administering the 6-minute Walk test.

- Straight line out and back < 50 ft
- Straight line out and back 50–99 ft
- Straight line out and back 100 ft
- Straight line out and back >100
- Circle/oval
- Square/rectangle
- Path is variable
- Other \_\_\_\_\_

*Display This Question: If Q2 = Circle/oval Or Q2 = Square/rectangle Or Q2 = Path is variable*

Q20 Please describe your exact dimensions

---

*Display This Question: If Q1 = Yes*

Q3 Please explain why you use this configuration/arrangement (select all that apply)

- Space available
- Clinic is crowded
- Following clinic protocol (preset distance)
- Trained to complete it this way
- Following evidenced based guidelines
- Other \_\_\_\_\_

*Display This Question: If Q1 = Yes*

Q22 How do you measure the distance walked?

- Follow with a measuring wheel
- Calculate/count laps based on a preset distance
- Other \_\_\_\_\_

Q4 Does your work environment have an open walking space measuring 100 ft long?

- Yes
- No

Q5 Do you administer the 6-Minute Walk test in any other work settings?

- Yes
- No

*Display This Question: If Q5 = Yes*

Q6 Briefly discuss the configuration/arrangement (dimensions) you use for administering the 6-Minute walk test in this work setting.

- Straight line out and back < 50 ft
- Straight line out and back 50–99 ft

- Straight line out and back 100 ft
- Straight line out and back > 100 ft
- Square/rectangle
- Path is variable
- Other \_\_\_\_\_

*Display This Question: If Q6 = Circle/oval Or Q6 = Square/rectangle Or Q6 = Path is variable*

Q21 Please describe your exact dimensions

---

*Display This Question: If Q5 = Yes*

Q7 Please explain why you use this configuration/arrangement? (select all that apply)

- Space available
- Clinic is crowded
- Following clinic protocol (preset)
- Trained to complete this way
- Following evidenced based guidelines
- Other \_\_\_\_\_

*Display This Question: If Q5 = Yes*

Q23 How do you measure the distance walked?

- Follow with a measuring wheel
- Calculate/count laps based on a preset distance
- Other \_\_\_\_\_

Q8 Do you know about the American Thoracic Society 6-Minute Walk test protocol?

- Yes
- No

Q9 Do you know about the Academy of Neurologic Physical Therapy recommended clinical practice guidelines for the 6-minute Walk test?

- Yes
- No

Q10 Are you a licensed Physical Therapist?

- Yes
- No

Q11 Are you an APTA member?

- Yes
- No

Q12 How many years have you been a practicing clinician?

- <1 year
- 1–3 years
- 4–5 years
- 6–10 years
- 11–15 years
- 16–20 years
- 21–30 years
- 31+ years

Q13 Approximately what percentage of your patient population is neurological?

- 0%
- 1–20%
- 21–40%
- 41–60%
- 61–80%
- 81–100%

Q14 On average, how many patients with Parkinson’s Disease do you treat a week?

- 0
- 1–3
- 4–6
- 7–9
- 10+

Q17 Please note, this is the final question. By selecting “Next,” you will submit your answers and thus conclude the survey. What type of setting is your primary, and if applicable, additional work setting(s)?

---

Please answer at least one but you may select multiple additional: Primary (1) Additional (2)

---

Academic Institution	<input type="radio"/>	<input type="radio"/>
Acute Care hospital	<input type="radio"/>	<input type="radio"/>
Health and wellness facility	<input type="radio"/>	<input type="radio"/>
Hospital-based outpatient facility or clinic	<input type="radio"/>	<input type="radio"/>
Industry	<input type="radio"/>	<input type="radio"/>
Inpatient rehab facility	<input type="radio"/>	<input type="radio"/>
Patient’s home/home care	<input type="radio"/>	<input type="radio"/>
Private Outpatient Office or Group Practice	<input type="radio"/>	<input type="radio"/>
Research Center	<input type="radio"/>	<input type="radio"/>
School system (preschool/primary/secondary)	<input type="radio"/>	<input type="radio"/>
Skilled Nursing facility/Long term care	<input type="radio"/>	<input type="radio"/>
other	<input type="radio"/>	<input type="radio"/>

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