



Differences in performing standardized assessment of fine motor skills between czech and slovenian occupational therapists: Nine Hole Peg Test.

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SUMMARY/ABSTRACT

Background: For standardized assessment of fine motor skills, therapists use the Nine Hole Peg Test (NHPT). The subject's task is to put nine pegs into the holes in the pegboard one by one as quickly as possible and then return them to the container, while their time is measured. The aim was to find out whether occupational therapists from the Czech Republic and Slovenia react uniformly in selected specific situations during testing using the NHPT and whether they agree in their evaluation.

Methods: An online survey was distributed to Czech and Slovenian occupational therapists in their native languages. It contained short videorecording of situations showing pegs falling on the pegboard, on the table, on the floor or in the lap, as well as pegs bouncing off the container as the attempt is completed. Collected data were analysed using descriptive statistics.

Results: Answers from 87 Czech and 67 Slovenian therapists showed significant differences between their reactions to specific situations and their ways of evaluating them. They disagreed on the ways of (not) counting the attempt with the specific situation, timing of stopping the attempt, encouraging the completion of attempt, helping to pick up fallen pegs, explaining a repeated attempt, the final position of the pegs after completing the task.

Conclusions: For truly objective testing, a NHPT manual containing rules that unify how therapists shall respond to specific situations and evaluate them is essential. Monitoring the frequency of specific situations and the number of initiated attempts to complete the NHPT is recommended.

KEYWORDS

occupational therapy, standardized hand assessment tool, upper limb assessment, fine motor ability, test administration situations, Nine Hole Peg Test.

DOI: [10.61983/lcrh.v62i1.90](https://doi.org/10.61983/lcrh.v62i1.90)

1 INTRODUCTION

Occupational therapists (OTs) provide health care services mostly to people with disabilities to help them achieve the maximum possible level of self-sufficiency in daily living, work and leisure activities. They therefore very often focus on the assessment of upper limb function, including fine motor skills evaluation. (Sládková, 2023; Švestková a Svěcená, 2014)

Due to the current trend to do evidence-based practice in rehabilitation, it is recommended to prefer standardized tests. It is crucial to select an appropriate test not only according to its psychometric properties, but also according to the time required for testing, language of instructions and/or manual, or other factors. In addition, this allows the performance of the tested subject to be objectively compared with a healthy population using the norms of the test. (Kvapilová et al., 2019)

The Nine Hole Peg Test (NHPT) is a standardized test used to objectively assess fine motor skills of hands in different groups of patients and clients. The mostly recommended Rolyan version of the NHPT

consists of a pegboard with nine holes, a circular container and nine pegs. The subject's task is to insert all nine pegs one by one into the holes as quickly as possible and subsequently return them to the container. The time required to complete this task is measured, rounded to hundredths of a second. Time measuring starts at the exact moment when the person touches the first peg. The end of time measuring then occurs exactly when the last peg hits the container. The dominant hand is tested first, then the non-dominant hand. (Mathiowetz et al., 1985; Rybářová et al., 2021)

Administration of the NHPT takes approximately 10 minutes (Kvapilová et al., 2019).

Therapists performing the NHPT must follow precise instructions from normative study by Mathiowetz et al. (1985) or a manual, in the Czech environment that by Rybářová et al. (2021). They must therefore give the tested person specific verbal instructions in the exact wording of the manual in the language he/she speaks and show him/her an example of the required task.

The problem is that the instructions for the NHPT (Mathiowetz et al., 1985) do not contain instructions on how to react in certain situations that may relatively frequently arise, nor do they contain rules on what (not) to consider a valid attempt. Therefore, different rules for the NHPT administration have been established in foreign studies.

For example, Grice et al. (2003) followed instructions by Mathiowetz et al. (1985), but they stop testing and start the attempt again when a peg dropped or when the testing was interrupted in any way.

Neither Czech nor Slovenian version of the manual for the NHPT was published before 2021, the year of the survey.

The Czech survey revealed that therapists didn't follow the basic rules of performing this test. Some of them gave the verbal instructions in their own words, others didn't show the example of the required task. (Rybářová et al., 2022)

The NHPT was chosen as the only standardized tool for assessing fine motor skills in Slovenian study focused on people with multiple sclerosis because it has good validity and sensitivity. (Slakovic et al., 2019)

The results of study in people with Parkinson's disease (Proud et al., 2019) showed excellent inter-rater reliability. No added rules for solving the specific situations were mentioned.

Excellent intra-rater inter-session reliability was reported in patients with spastic unilateral cerebral palsy (Mendoza-Sánchez et al., 2022). The authors referred to the Mathiowetz's study (1985), but they started with the non-affected hand instead of the dominant hand. One practice of the test was performed followed by assessment of both hands.

The NHPT was also used in many recent studies focused on people with ataxia in Germany (Hermle et al., 2024), people with multiple sclerosis in the Czech Republic (Novotna et al., 2024), people with stroke in China (Liu et al., 2024), people suffering from a brain tumor in Germany (Maurer et al., 2024), people after acquired brain injury in the Czech Republic (Hoidekrová et al., 2021), people with Parkinson's disease in Brazil (Banks et al., 2024), people with osteoarthritis in Spain (Gracia-Ibáñez, 2023) and others.

No rules for specific situations were set in most of mentioned studies (Mathiowetz et al., 1985; Slavkovic et al., 2019; Proud et al., 2019; Mendoza-Sánchez et al., 2022; Hermle et al., 2024; Novotna et al., 2024; Liu et al., 2024; Maurer et al., 2024; Hoidekrová et al., 2021; Banks et al., 2024; Gracia-Ibáñez, 2023).

The NHPT results can be objectively compared with existing norms, e.g. by descriptive statistics using population means and standard deviations (Furka et al., 2023).

2 OBJECTIVE

The aim of the survey was to find out whether occupational therapists from the Czech Republic and Slovenia react uniformly to selected specific situations during testing using the NHPT and whether they also agree in their evaluation.

3 GROUP AND METHODS

An online cross-sectional survey among occupational therapists was used. It was developed in Czech and Slovenian languages. The Czech version of survey was prepared first. It contained basic demographic questions (e.g. type of workplace) and also questions focused on performing the NHPT. The most important part of the questionnaire consisted of five questions with video-examples of specific situations arising

during performing the NHPT. They are available from a youtube channel (<https://www.youtube.com/@bp-standardizovanetestynaj9140/videos>). The videos are based on simulated testing of a healthy adult volunteer who signed an informed consent prior to filming to allow their use for this questionnaire and for the purpose of publications or conference presentations. The volunteer cannot be identified from the videos.

Multiple choice answers with a possibility of adding respondent's own comment were used. In these answers, the respondents expressed how they would react in the particular situations and how they would evaluate them. First, the questionnaire was piloted to eliminate any technical errors or to reformulate incomprehensible questions or answers offered.

The Czech survey was distributed via e-mail and social networks among Czech therapists in March to April 2021 with the help of the Czech Association of OTs. Responses from 121 respondents were obtained applying also the snowball method. The answers from people without finished formal occupational therapy education were excluded. A total of 87 Czech anonymous answers were analyzed using descriptive statistics.

The questionnaire was afterwards translated into English by a Czech occupational therapist. Slovenian occupational therapists translated it from English into Slovenian. It was used as a technical translation of the Czech questionnaire for this pilot Czech-Slovenian research. Both the Czech-English and the English-Slovenian translations were verified by back-translation using an online translator. Subsequently, the Slovenian Association of OTs was also asked to help with the distribution of the questionnaire.

A total of 67 answers from Slovenian therapists were obtained in July and August 2021. These answers were analyzed in the same way as the Czech survey. The results of both versions of the survey were compared and compiled in the form of annotated tables and graphs.

The study was not submitted to any ethics committee for approval, as it was a questionnaire designed exclusively for therapists and was completed strictly anonymously. No respondent can be identified. The person appearing in the videos has signed an informed consent confirming that they agree to their public release.

4 RESULTS

The Czech survey was answered by 121 respondents. Answers from 34 Czech occupational therapy students were excluded. The Slovenian version was filled by 67 occupational therapists.

The highest education of the respondents was as follows: Master's degree 9 Czechs and 10 Slovenian, bachelor's degree 47 Czechs and 57 Slovenian, when 31 Czechs had another type of education that qualifies them for the profession under Czech legislation.

Among both Czech and Slovenian respondents ($n=154$), most occupational therapists (38%) had been working in the field for more than 15 years. Another 23% of respondents had been working as OTs for less than 5 years, 18% had between five and nine years of experience in the field, and 14% had been working as OTs for between ten and fourteen years. The remaining 7% of respondents indicated that they were not working as OTs at the time of data collection.

OTs working in the field less than 14 years prevailed among the Czech respondents (52 persons) compared to OTs with longer experience in the field (24 persons). Among Slovenian OTs, the groups were more balanced, as 32 of them had been working as an occupational therapist for up to 14 years and 35 of them for 15 years or more.

The majority of Slovenian (47) and Czech therapists (52) were working in a healthcare facility at the time of the survey. The second largest group consisted of therapists working in social services (31 Czech and 8 Slovenian respondents). Another 5 Czech and 7 Slovenian therapists worked in an educational institution and four Czech respondents worked in a prevocational assessment center. Many respondents reported working in several workplaces at the same time.

The Nine Hole Peg Test (NHPT) was available to about a fifth of the Czech therapists (18) and half of the Slovenian therapists (30). A total of 18 Czech and 26 Slovenian OTs had experience of testing at least five people by the NHPT. They answered questions focused on specific situations that can arise during performing the NHPT.

Most of these experienced respondents had a bachelor's degree in occupational therapy (10 Czech and 22 Slovenian therapists). Another four respondents from each country were Masters. The rest of Czech respondents (4) stated that they had received other education in this field.

Most of the respondents with experience in using NHPT in practice (39%) worked in the field for more than 15 years. Other groups were therapists working less than five years (20%) and therapists working from five to nine years (20%), followed by therapists working in the field from 10 to 14 years (16%). One respondent didn't work as an occupational therapist in the time of collecting data (5%). Details of respondents' length of experience in the field are described in Figure 1.

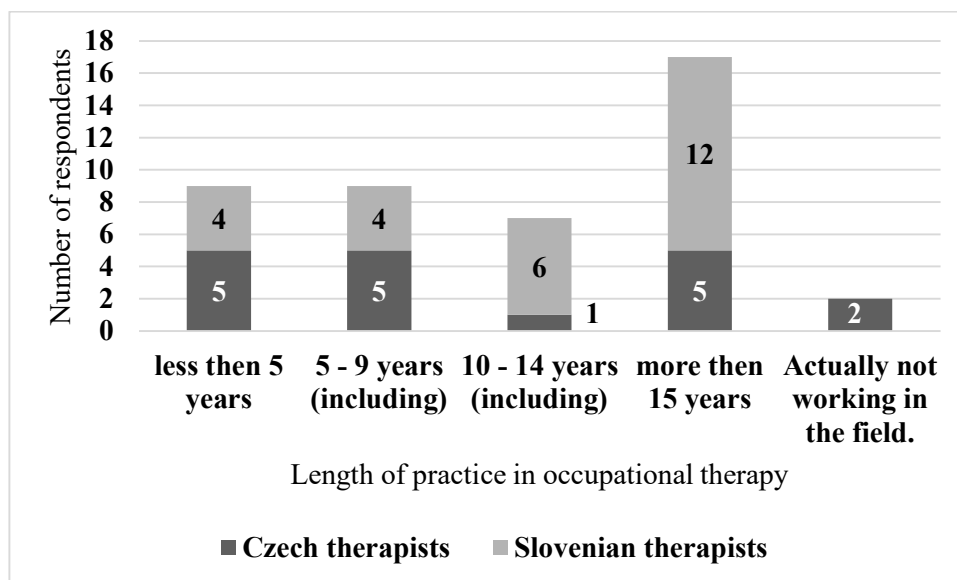


Figure 1 - Length of practice in occupational therapy

Three quarters of respondents who used NHPT more than five times in their practice mostly worked in health care facility (34). Others were employed in social services or social institutions (5), educational institutions (4) or elsewhere. Details about the type of their workplace are presented in Table 1. Multiple employers were mentioned by four Czech OTs.

Table 1 - Type of respondents' workplace

Type of respondents' workplace	Number of Czech therapists	Number of Slovenian therapists
health care facility	12	22
social services / social institution	4	1
social and health care facility	0	1
educational institution	3	1
prevocational assessment center	1	0
community	0	1
own practice	1	0
currently not working	2	0

The results for each situation are presented in the following paragraphs. The total numbers of responses may vary because the respondents could select multiple answers.

1st situation: One peg fell on the pegboard and another on the table, both pegs were consecutively picked up by the tested hand and the person completed the task.

Responses to the first situation confirmed significant differences between the reactions of Czech and Slovenian therapists (see Figure 2). Generally, most therapists (17) let the tested person pick up the dropped pegs and continue. They will start a new attempt, if the person stops himself/herself. The second most frequent answer was a physical entry of the evaluator into the pegboard area (answer A presented in Figure

2). Some therapists would not count this attempt (answers E & F). Testing would be immediately interrupted by two Czech and five Slovenian therapists.

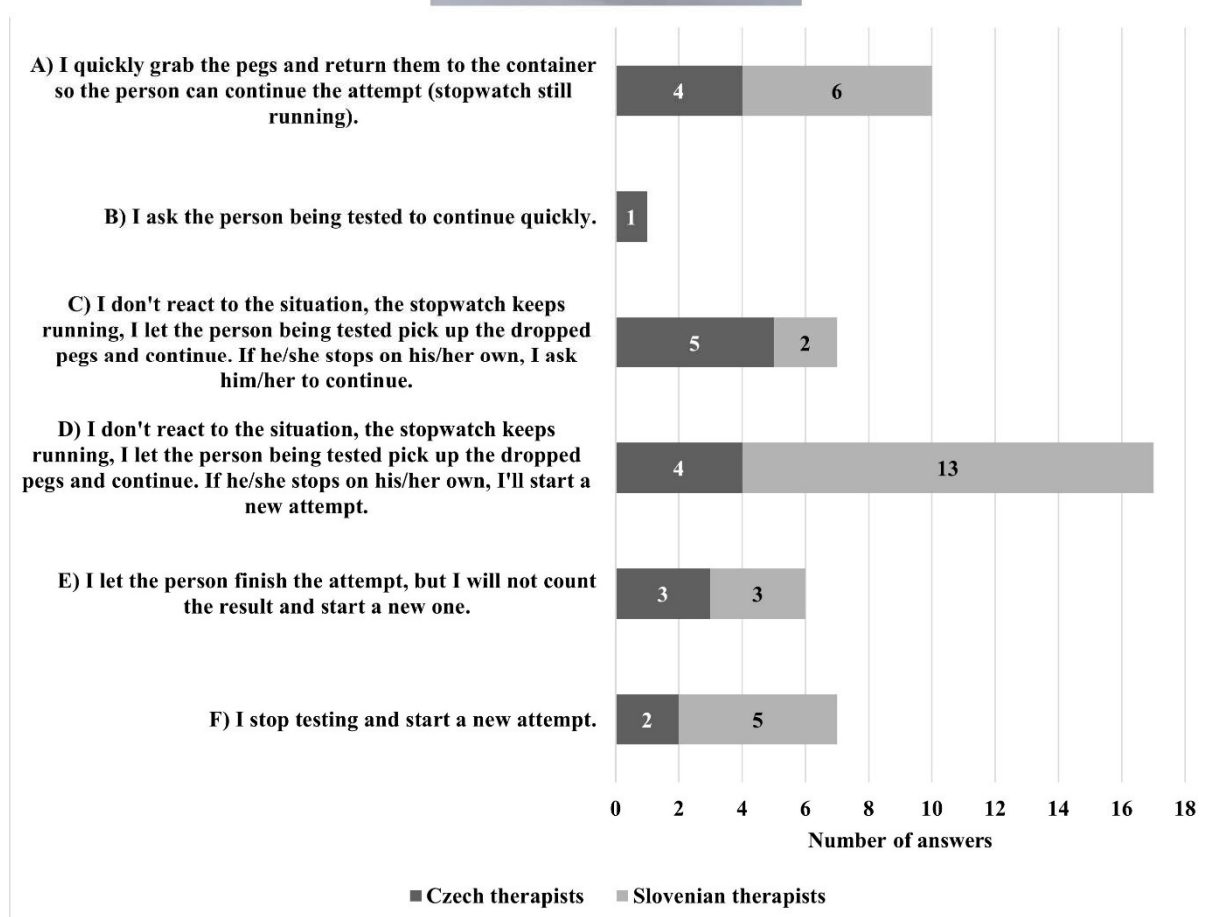


Figure 2 - Czech and Slovenian therapists' reactions to the first situation in the NHPT.

2nd situation: Two pegs fell into person's lap. One peg was picked up by the tested hand, the other was raised up by the non-tested hand, passed back to the tested hand and placed in the hole.

Slovenian therapists mostly agreed not to count this attempt. A total of 72% of their answers describes that they would immediately stop the attempt and start it again, another 24% answers stated that they would start the attempt again after completing the non-counted one. Only one respondent (6%) would count the attempt. The Czech answers differ more from each other than the Slovenian ones. Most Czech therapists (38% answers) belonged to the answer which was mostly chosen also by Slovenian therapists. Other Czech therapists would let the subject complete the task, but count a newly started attempt (25% mentioned answers). Another 19% answers stated that they would let the subject complete the attempt and encourage them to finish the task when he/she stops. However, another 13% of the responses expressed that they would do almost the same, with the difference that they would start a new attempt if the subject stopped himself. One respondent (6%) would prompt the subject to complete the attempt.

3rd situation: A peg fell to the floor. The person raised it by the tested hand and put it back to the container during the NHPT.

Most Czech (61%) and Slovenian (74%) therapists would react to this situation by immediate stopping the testing and starting a new attempt. To finish this attempt and starting it again chose another 28% Czech

and 7% Slovenian therapists, while 6% Czech and 11% Slovenian therapists would start a new attempt only if the subject stopped himself. Only 6% Czech and 7% Slovenian therapists would help the subject to quickly pick up the pegs and return them to the container.

4th situation: Several pegs bounced off the container during returning them in container and fell onto the table and the floor.

The greatest consensus in reaction to this situation was in the response: “I will not count the attempt, warn the subject that the pegs must remain in the container and start a new attempt”, which was chosen by 59% Czech and 68% Slovenian therapists. The attempt would be started again without explaining the reason by 29% Czech and 4% Slovenian therapists. Another 6% Czech and 24% Slovenian therapists would stop measuring the time to complete this task when the last peg touched the container, regardless of the fact that not all pegs were left in. The others would stop timing when all the pegs are left in the container.

5th situation: One peg was quickly picked up by the tested hand from the lap where it had fallen during the task.

Most of Czech (67%) and Slovenian (67%) therapists would not count this attempt, but their ways of reacting during this situation differ a lot, as presented in Figure 3. The attempt would be counted by 17% Czech and 30% Slovenian therapists. Other 6% Czech and 4% Slovenian therapists would count it, but they would subtract the adequate time from the total time. Two Czech therapists would write a note to the record sheet.

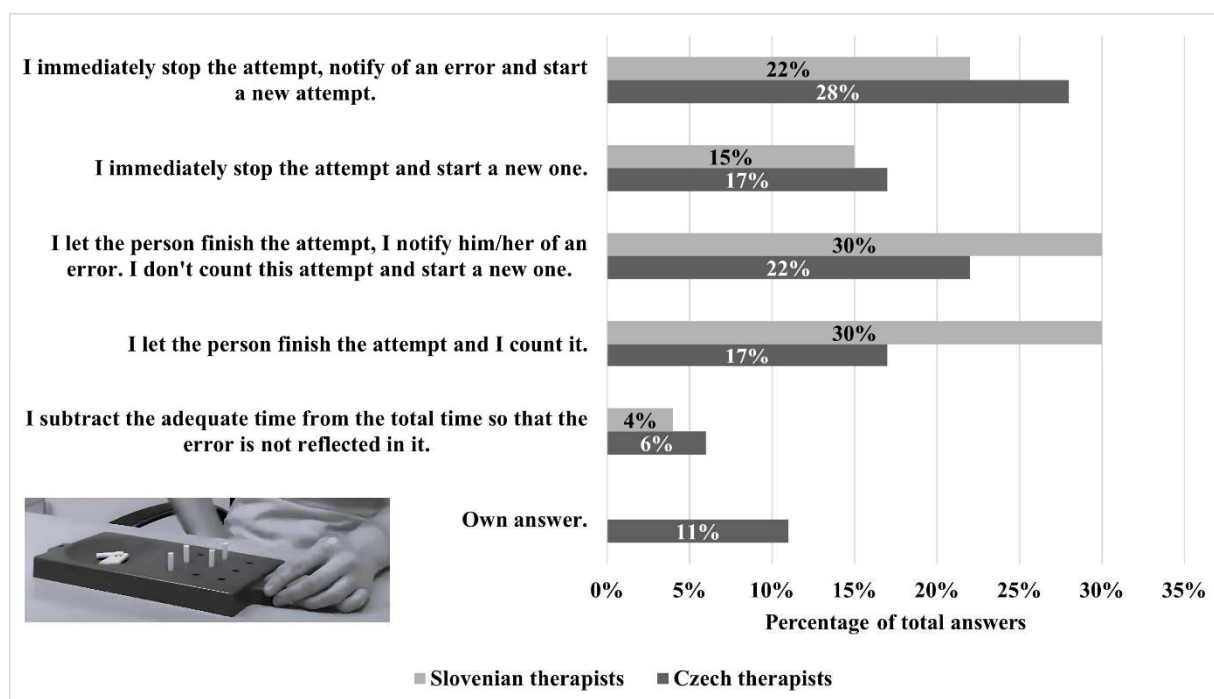


Figure 3 – Reactions of Czech and Slovenian therapists to the fifth situation in the NHPT.

To sum up, neither Czech nor Slovenian therapists clearly agreed on the evaluation of the NHPT testing when the mentioned situations occurred, nor on the ways how to react to them during testing.

5 DISCUSSION

Limitations in upper limb functions can have a major impact on the person's self-sufficiency. Conducting objective diagnostics of fine motor skills using standardized tests can be crucial for persons with disabilities for adequate determination of the level of disability, the level of various social benefits, and return to work.

The NHPT is a standardized test for fine motor skills which should be administered uniformly by all therapists in the world. Most studies that have used NHPT refer to the methodology published in the American normative study (Mathiowetz et al., 1985).

Therapists working with non-English speaking patients or clients need a manual for the NHPT in their mother tongue. That is why different translations have been produced.

Rodová et al. (2021) confirmed that occupational therapists from the Czech Republic used the NHPT already in 2019.

Rybářová et al. (2022) found that they tested persons by the NHPT according to different Czech versions of the manual before October 2021. It was found that most of them even gave the instructions to the subjects in their own words and showed a demonstration of the task. This fact may be related to the absence of a manual for the NHPT officially published in Czech language. (Rybářová et al., 2022)

As it was mentioned before, additional rules were set in different studies because of specific situations that commonly arise in practice. Temporiti et al. (2023) followed Grice's instructions for NHPT (2003) but they added two more rules: "If the peg was dropped on the table, the participants were instructed to pick it up and continue. If the peg was dropped on the floor, the participants were instructed not to pick it up, but to continue in the test." They might react to a high frequency of falling a peg on the table in practice. From this, however, it is not clear how they performed and completed the testing in the case where the peg fell to the floor when it was being placed in the holes in the pegboard. They must have missed at least one peg when returning them to the container.

Watanabe et al. (2022) immediately stopped testing by NHPT when a peg was dropped outside the pegboard which is consistent with Grice (2003).

Feys et al. (2017) points out some additional rules for certain situations in the Multiple sclerosis functional composite (MSFC): administration and scoring manual revised in October 2001 (Fischer et al., 2001). Accordingly, the therapist should immediately pick up the peg from the floor and return it to the container. If the peg falls on the table, therapist should ask the tested person to continue. If he or she repeatedly engages the untested hand or if the entire test falls to the floor, therapist should interrupt the testing.

Thus, neither Grice (2003) nor Temporiti (2023) nor the manual for testing people with multiple sclerosis (Fischer et al., 2001) mentioned by Feys et al. (2017) agreed on a rule for a peg falling to the floor or to the table.

Our survey showed, similar to the aforementioned studies, that neither Czech nor Slovenian OTs agree on the following issues when the five different specific situations presented in our survey occurred during the NHPT:

- count / do not count the attempt
- stop testing immediately / stop testing after completing the wrong attempt / stop testing only when the subject stops himself/herself / do not stop testing
- encourage the completion of the attempt / say nothing
- help / do not help pick up the fallen pegs during an attempt
- explain / do not explain the reason for repeating the attempt
- subtract / do not subtract the time when something was done wrong
- the pegs must / do not have to remain in the container when they are returned

Missing or differing rules for these particular situations make comparisons of different studies using the NHPT difficult, as the differences between them might be caused just by different testing procedures and evaluations of the test results. Thus, any comparison studies, systematic reviews or meta-analyses may be loaded with bias.

No rules have been found in published studies for situations such as a peg falling into the lap or a peg bouncing off the container. Only the manual for testing people with multiple sclerosis (Fischer et al., 2001) mentioned a rule for involving the non-tested hand according to which such an attempt must be interrupted. According to our survey, the reaction of most Slovenian therapists would be in agreement with it.

The answers from the Czech and Slovenian therapists were taken into account when creating the Czech Extended Version of Manual for Nine Hole Peg Test, which was published in October 2021 (Rybářová et

al., 2021). This new manual was enriched with new rules that should unify the way to react to situations that may arise during testing, as well as the way how to evaluate such attempts.

Accordingly (Rybářová et al., 2021), attempts in which situations number one or four happened should be counted, although most Slovenian and some Czech OTs would do the exact opposite according to our survey. The new rules were established in view of the high frequency of pegs falling on the table or peg-board and the emphasis on performing the test task as quickly as possible. This is also because sometimes, due to the laws of physics, the quickly returned pegs bounce off the container. Even in the instructions mentioned by Mathiowetz et al., (1985), a subject was not instructed to put the pegs back so that they would remain in the container.

Conversely, when situations two, three or five occur, testing should be stopped immediately, and the attempt should be started again according to the Czech extended NHPT manual (Rybářová et al., 2021). The most frequently selected answers of both Czech and Slovenian therapists mostly correspond to the extended NHPT manual in our survey. However, there was also considerable variability in the timing of the termination of testing.

Surprisingly, in published English articles, there is only a few mentions (Grice et al., 2003; Temporiti, 2023; Watanabe et al., 2022; Feys et al., 2017) of rules how they dealt with some specific situations (most often a peg falling on the table or floor). Moreover, there is no information about the frequency of these specific situations in their tested population, despite the fact they commonly occur during testing by the NHPT.

Rotbartová (2022) described the number of times she had to stop testing people with multiple sclerosis because of occurring specific situations (e.g. the subject grabbed two pegs at once, helped himself with his untested hand, the peg fell on the ground or in his/her lap, the subject stopped himself/herself, the peg was not completely tucked into the hole).

Most of these situations were also recorded by Nováková (2021) during testing people with rheumatoid arthritis and with osteoarthritis of the hands. She had to stop at least one attempt of the NHPT performed according to the Czech extended NHPT manual in 74% subjects.

Nájemníková (2024) also often faced to specific situations that led to the annulment of some attempts when testing people after stroke according to the Czech extended manual.

Due to the observed considerable differences between Czech and Slovenian therapists in evaluating particular situations and responding to them during testing, we recommend considering translating the Czech manual for the NHPT into other languages, especially into English, establishing its reliability and afterwards using it in clinical practice or in research studies. We also suggest monitoring the frequency of specific situations and the number of initiated attempts to complete both NHPT subtests when retesting patients or clients. This could be a way to assess the quality of the NHPT task in addition to the time required to complete it.

Assessing the frequency of these situations may have been valuable in the study, which examined the effect of four different acoustic environments (from silence to rock music) on the performance of 60 people in the NHPT (Adamo et al., 2024). They intended to evaluate the way the NHPT was performed in more detail. Therefore, they measured the duration of several sub-phases of this task. They could also objectively assess quality of their subjects' performance in the NHPT by monitoring the frequency of incidence of specific situations.

A limitation of this study was mainly the small sample size of respondents from the Czech Republic and Slovenia due to the lower number of occupational therapists in the countries and the number of members of their national occupational therapy associations, as well as the lower return rate of questionnaires. In this survey we managed to obtain valid responses from 87 Czech and 67 Slovenian therapists, which corresponds to 6.4% of Czech and 11.9% of Slovenian occupational therapists practicing in the country in 2021 according to the numbers published by the Council of Occupational Therapists for European Countries (Council of Occupational Therapists for the European Countries, 2021). Our results should be verified with a larger sample of therapists around the world.

Another limitation of this survey was the inability to identify the specific workplace of individual respondents due to guaranteeing their anonymity. Thus, it is not possible to decide whether therapists differ in their ways of responding to specific situations and evaluating them even within the same workplace.

6 CONCLUSIONS

In the NHPT, significant differences were found in the ways of responding to five selected specific situations and evaluating them between Czech and Slovenian therapists. The results suggest that for truly objective testing of fine motor skills, sufficiently detailed manuals in different (native) languages shall be a routine part of standardized objective tests. The NHPT manual should contain rules unifying how therapists respond to specific situations and how they evaluate them. It may be convenient to monitor the frequency of specific situations and the number of initiated attempts to complete both NHPT subtests in clinical practice and research studies.

7 ZUSAMMENFASSUNG

Hintergrund: Zur standardisierten Beurteilung der Feinmotorik verwenden Therapeuten den Nine Hole Peg Test (NHPT). Die Testperson hat die Aufgabe, neun Stifte nacheinander so schnell wie möglich in die Löcher der Stecktafel zu stecken und sie dann in den Behälter zurückzulegen, wobei die Zeit gemessen wird. Ziel war es, herauszufinden, ob Ergotherapeuten aus der Tschechischen Republik und Slowenien bei der Testung mit dem NHPT in ausgewählten spezifischen Situationen einheitlich reagieren und bei ihrer Bewertung gleich vorgehen.

Methoden: An tschechische sowie slowenische Ergotherapeuten wurde eine Online- Umfrage in ihrer Muttersprache verteilt. Sie enthielt kurze Videoaufnahmen von Situationen, die zeigen, wie die Stifte nach Beendigung des Versuchs auf die Tafel, auf den Tisch, auf den Boden oder in den Schoß fallen, oder vom Behälter abprallen. Die gesammelten Daten wurden mit Hilfe der deskriptiven Statistik ausgewertet.

Ergebnisse: Die Antworten von 87 tschechischen und 67 slowenischen Therapeuten zeigten signifikante Unterschiede zwischen ihren Reaktionen auf bestimmte Situationen und ihrer Bewertungsart. Sie stimmten nicht überein in Bezug auf die Art und Weise, wie der Versuch mit der spezifischen Situation (nicht) verrechnet wird, auf den Zeitpunkt der Versuchsbeendigung und die Ermutigung dazu, auf die Hilfe beim Aufheben heruntergefallener Stifte, Erklärung eines wiederholten Versuchs und die endgültige Position der Stifte nach Beendigung der Aufgabe.

Schlussfolgerung: Für eine wirklich objektive Testung ist ein NHPT-Handbuch mit Regeln notwendig, die vereinheitlichen, wie Therapeuten auf bestimmte Situationen reagieren und diese bewerten sollen. Es wird empfohlen, die Häufigkeit bestimmter Situationen und der Anzahl der eingeleiteten Versuche, das NHPT abzuschließen, zu verfolgen.

8 ACKNOWLEDGEMENTS

We would like to thank all Czech and Slovenian occupational therapists who helped us with completing this survey.

The study was supported by X and Y.

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