Research Report

Manual Therapy Techniques in Standardized Clinical Terminology System: A Coverage Analysis of SNOMED CT and OMOP CDM

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Background Standardized clinical terminology is essential for semantic interoperability and for effectively utilizing clinical data in digital health, research, and artificial intelligence (AI). Although manual therapy is widely used in physical therapy practice, its techniques have not yet been systematically integrated into major standardized terminology systems such as systematized nomenclature of medicine clinical terms (SNOMED CT) and observational medical outcomes partnership common data model (OMOP CDM).

Purpose The purpose of this study was to evaluate the status of terminology standardization for manual therapy techniques within SNOMED CT and OMOP CDM, including the identification of alternative or broader concepts when direct representations were unavailable.

Study design Terminology evaluation study

Methods Twenty-nine techniques were selected through a literature review, educational resources, and expert consensus. Each technique was evaluated for direct representation in SNOMED CT and for mapping within the OMOP CDM. Techniques not directly defined were assessed for the availability of broader, more generic concepts.

Results Among the 29 techniques, 15 (51.7%) were standardized in at least one system, while 14 (48.3%) were not standardized and could only be described using higher-level categories. The standardization rates were 40.0% for orthopedic techniques, 44.4% for soft tissue techniques, 60.0% for nerve techniques, and 80.0% for other integrative approaches.

Conclusions Nearly half of the manual therapy techniques commonly used in physical therapy lack independent representation in SNOMED CT and OMOP CDM. Although generic categories allow for minimal documentation, the absence of detailed, granular concepts diminishes semantic accuracy, impedes cross-institutional comparability, and limits multicenter research and AI-based applications.

Key words Manual therapy; OMOP CDM; SNOMED CT; Standardized terminology.

INTRODUCTION

Recent advances in precision medicine and artificial intelligence (AI) based clinical decision support systems (CDSS) have accelerated the medical landscape.[1] The continuous accumulation of real-time clinical information from sources such as electronic medical records, insurance claims, wearable devices, and patient self-reports makes the development of a robust big data research infrastructure imperative.[2–5] In this environment, achieving interoperability among institutions, countries, and data platforms is considered a critical challenge.[6] When the same treatment or disease concept is inconsistently recorded, meaningful comparisons and analyses are almost impossible regardless of the amount of data.[6] In this context, the lack of standardized terminology for treatment interventions can

significantly impair the reliability of evidence-based outcome assessment and compromise the integrity of training datasets for AI models.[7] Therefore, for the advancement of precision medicine and clinical decision support systems, mapping treatment interventions to consistent and standardized terms is just as essential as standardizing diagnostic and evaluation data.[7]

Manual therapy refers to treatment techniques by which a physical therapist can relieve pain and restore function by applying mechanical stimulation to joints, muscles, nerves, or soft tissues using a hand or special tool.[8] It is considered a conservative alternative to surgery or medication, especially for the management of musculoskeletal and neurological diseases.[9] Typical manual therapy techniques include joint mobilization, soft tissue techniques, and nervous interventions.[8] These techniques have distinct differences in application target, stimulation methodand treatment purpose, and have been proven to be effective in various clinical conditions such as low back pain, neck pain, adhesive articular capsulitis, sciatic neuralgia, and recovery after stroke.[10–15]

Despite the wide variety and clinical characteristics of manual therapy techniques, the conceptual framework for systematically defining and classifying them has not yet been fully reflected within the international standardized terminology system. Detailed clinical differences, such as specific techniques not being specified individually or similar but different techniques being incorporated into a comprehensive higher-level concept, are often not reflected in the terminology system. This lack of standardization makes it difficult to incorporate manual therapy techniques into electronic medical records, billing data, and research databases, which can lead to poor data quality, difficulties in comparing clinical outcomes, and inconsistencies in AI model learning data. For instance, although billing codes such as Current Procedural Terminology 97140 (manual therapy techniques, one or more regions, each 15 minutes) indicate that manual therapy is frequently administered and reimbursed in clinical practice, these codes were designed for administrative purposes and do not capture the diversity of techniques used.[16] Physical therapists primarily deliver and document these interventions in clinical practice rather than physicians, and their documentation practices differ substantially from physician-centered records.[17] Although billing data confirm the prevalence of manual therapy, the specific techniques applied are often not captured with sufficient granularity. Generic terms, such as manual therapy, may be adequate for reimbursement purposes but are insufficient for research, quality assessment, and precise documentation. Therefore, the inadequate representation of

manual therapy in standardized clinical terminologies constitutes a critical barrier to the interoperability of both routine clinical practice and international data.

International frameworks, such as the systematized medical nomenclature for medicine clinical terminology (SNOMED CT) and observational medical outcomes partnership common data model (OMOP CDM) have been developed to address the need for semantic interoperability of clinical data.[18,19] SNOMED CT is a comprehensive clinical terminology system that encompasses diagnosis, symptoms, procedure, and anatomical structure, and has been widely adopted throughout the global healthcare system to support standardized data representation and integration.[18] OMOP CDM provides a common schema and vocabulary scheme to transform heterogeneous medical data sources into a unified format based on these standardized clinical terms, enabling multi-center research, drug use analysis, and large-scale AI model development.[19] These frameworks are essential for collaborative research and digital healthcare innovations. However, most standardization efforts have mainly focused on diagnosis, drugs, procedures, and laboratory values.[20] Therapeutic domains such as physical therapy and rehabilitation, are still underrepresented in this standardized vocabulary.[20] Although physical therapy–specific documentation systems are sufficient for direct patient care, billing, and compliance, they are largely narrative-based and siloed within institution-specific electronic medical records. They lack the structured, interoperable coding required to support big data applications, such as multi-center research, cross-institutional analytics, or AI-driven secondary use of data. For example, French et al. investigated how physical therapy assessments are represented within OMOP CDM.[20] The study found that 53.1% of neurological assessments and 51.9% of orthopedic assessments were not mapped at all within OMOP CDM. Furthermore, even mapped assessments were often linked to multiple overlapping concept identifiers, averaging 2.2 per concept in neurology and 4.3 in orthopedics. These findings represented the limited and inconsistent representation of even basic functional assessment and the urgent need for standardization and mapping of therapeutic interventions, such as manual therapy in clinical vocabulary.

This study aimed to evaluate the extent to which diverse manual therapy techniques commonly used in physical therapy practice are formally defined or represented within international standardized clinical terminologies, namely SNOMED CT and OMOP CDM. By evaluating their representational status and degree of standardization, this study aimed to inform the development of structured,
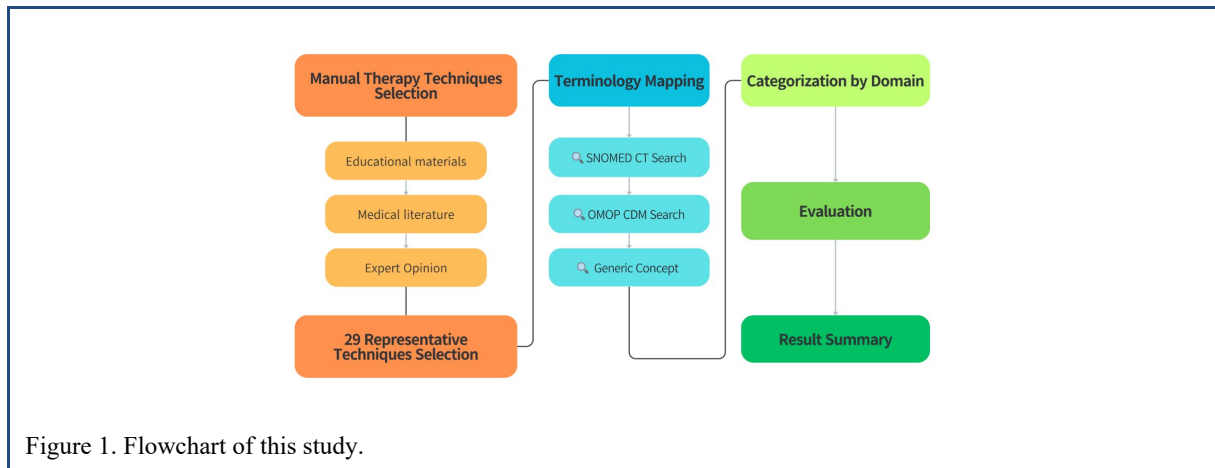
Figure 1. Flowchart of this study.

semantically precise data frameworks that can support advanced clinical documentation, research, and digital health applications in the domain of physical therapy.

METHODS

Terminology selection

A flowchart of this study is presented in Figure 1. This study employed a structured methodology to determine whether manual therapy techniques commonly used in physical therapy are appropriately represented in international standardized clinical terminologies. Candidate techniques were identified through a comprehensive review of multiple information sources. Educational materials were examined, including curricula published by professional organizations such as the Journal of Orthopaedic and Sports Physical Therapy (JOSPT), the American College of Physicians (ACP), and the American Osteopathic Association (AOA). In addition, various medical literature was reviewed using databases such as MEDLINE, PubMed, Embase, and the Cochrane Library. Reference textbooks widely used in manual therapy education were also consulted, including those authored by Maitland, Kaltenborn, Mulligan, and Cyriax. The relevant manual therapy techniques were collected from these sources. To ensure consistency, duplicate entries were removed, and synonymous or closely related terms were consolidated under standardized preferred terms.

Three licensed physical therapists, each with more than 10 years of clinical experience in manual therapy, evaluated the compiled list of techniques. Each expert independently assessed the techniques based on three criteria including clinical usefulness, frequency of mention in academic literature, and inclusion in professional educational programs. The techniques were further discussed when only two of the three experts initially agreed on their inclusion to ensure content validity and consensus. Only the techniques that received unanimous agreement among all three experts were included in the final list. Inter-rater agreement among the three experts was evaluated using Fleiss' κ to quantify the level of consensus. Disagreements were resolved through a consensus discussion. A total of 29 representative manual therapy techniques were finalized for further terminology evaluation (Table 1).

Procedures

For each selected manual therapy technique, three analytical steps were used to confirm its status in the standardized medical terminology systems. Registration status was confirmed on 24 July 2025.

1) SNOMED CT registration

For SNOMED CT, the reference version was the International Edition, July 2025 release. The official SNOMED International browser (https://browser.ihtsdotools.org/) was used to verify whether each technique was registered as an independent SNOMED CT concept. Searches were conducted using the original English terms.

2) OMOP CDM mapping

For the OMOP CDM, the reference standard was version 5.4 (model originally released on September 25, 2021) as implemented in the OHDSI Athena platform; OMOP vocabularies are updated on a scheduled basis (February and August). The OHDSI Athena platform (https://athena.ohdsi.org/) was used to determine whether each technique could be mapped to a standard concept within the OMOP CDM. Techniques mapped to either SNOMED CT or other OMOP standard vocabularies were categorized as mappable, while those without such mappings were classified as not mappable.

Table 1. Selection of manual therapy techniques

Technique	Expert consensus (n)	Selection
Accessory mobilization	3	Included
Active release technique	3	Included
Bobath therapy	3	Included
Chiropractic therapy	3	Included
Connective tissue massage	3	Included
Craniosacral therapy	3	Included
Cross friction massage	3	Included
Cyriax mobilization	3	Included
Fascial manipulation	3	Included
Functional mobilization	3	Included
High-velocity low-amplitude	3	Included
Instrument-assisted soft tissue mobilization	3	Included
Kaltenborn technique	3	Included
Lymphatic drainage massage	3	Included
Maitland technique	3	Included
Mobilization with movement	3	Included
Mulligan technique	3	Included
Muscle energy technique	3	Included
Myofascial release	3	Included
Nerve mobilization	3	Included
Neurodevelopmental treatment	3	Included
Osteopathic manipulative treatment	2	Included
Polarity therapy	1	Excluded
Proprioceptive neuromuscular facilitation	3	Included
Reflexology	1	Excluded
Rolfing	2	Excluded
Shiatsu	0	Excluded
Soft tissue mobilization	3	Included
Spinal manipulation	3	Included
Thai massage	1	Excluded
Thrust manipulation	3	Included
Trigger point therapy	3	Included
Tuina	0	Excluded
Visceral manipulation	3	Included
Vojta therapy	3	Included

3) Generic concept availability

For techniques not directly registered in SNOMED CT or OMOP CDM, an evaluation was conducted to determine whether representation through a more general, higher-level concept was possible. For example, although the Maitland technique may not be directly registered, it can be described more broadly as joint mobilization. These cases were classified as having generic concept availability, recognizing that indirect representation is feasible, though specific clinical nuances may not be fully captured.

Categorization and evaluation

The 29 techniques were categorized into four clinical application domains: orthopaedic, soft tissue, nerve, and others. Orthopaedic techniques included joint-oriented mobilization and manipulation methods, whereas soft tissue techniques included massage and myofascial release–based interventions targeting muscles, fascia, and connective tissues. Nerve techniques include neurodynamic and neurode-velopmental facilitation approaches. The others category was reserved for integrative or system-based therapies that could not be clearly assigned to a single category. The categorization was independently reviewed by three licensed therapists and finalized through their consensus. The SNOMED CT registration status, OMOP CDM mapping status, and the availability of generic conceptual alternatives were examined for each technique. Techniques directly defined in either SNOMED CT or OMOP CDM were considered standardized, whereas techniques lacking direct definitions but expressible only through broader concepts were regarded as non-standardized, reflecting the absence of specific semantic representation.

RESULTS

Among the 35 candidate techniques, 29 were ultimately included in the study. The agreement among the three experts was high (Fleiss' κ = 0.71), and 85.7% of the techniques (30 of 35) received unanimous ratings from all evaluators. The mapping status of each manual therapy technique, along with the available standardized alternative terms in cases where direct mapping was not possible, is provided in Table 2. Of the 29 manual therapy techniques investigated, 15 (51.7%) were registered directly in two standard vocabularies to confirm their standardized status (Table 3). The remaining 14 techniques (48.3%) were not defined as independent concepts in SNOMED CT or OMOP CDM and were therefore classified as non-standardized.

By category, orthopedic techniques were standardized to 4 of 10 (40.0%), soft tissue techniques to 4 of 9 (44.4%), nerve techniques to 3 of 5 (60.0%), and other integrated approaches to 4 of 5 (80.0%). Therefore, the other integrated approaches exhibited a relatively higher standardization rate. Most of the 14 non-standardized techniques were able to be expressed indirectly through higher-level concepts. For example, the Maitland, Kaltenborn, and Mulligan techniques can all be commonly expressed by co-mobilization, and trigger point therapy and fascia manipulation can be included in the fascia release.

DISCUSSION

This study investigated the 29 representative manual therapy techniques in two standardized clinical vocabularies: SNOMED CT and OMOP CDM. This study sought to provide a terminology analysis of therapeutic interventions in physical therapy, which has long been underrepresented in clinical terminology systems that primarily prioritize diagnostics, drugs, and laboratory data. The findings revealed that only 15 of 29 techniques, accounting for 51.7 percent, were formally registered as independent concepts in either SNOMED CT or OMOP CDM. The remaining 14 techniques were absent and not mappable. This indicated that commonly used therapeutic techniques in physical therapy were not conceptually integrated into standardized vocabularies, which posed a significant limitation for their use in digital health systems. An analysis of the standardization status of manual therapy techniques by clinical domain revealed that orthopaedic techniques showed the lowest standardization rate at 40.0%, followed by soft tissue techniques at 44.4%. Nerve techniques demonstrated moderate standardization at 60.0%, whereas integrative approaches categorized as "others" exhibited the highest rate at 80.0%.

These findings suggest that certain techniques based on integrative or neurodevelopmental manual therapy approaches were incorporated into international clinical terminologies relatively early, whereas orthopedic and soft tissue methods, which are more specific to physical therapy, have yet to be systematically defined. Especially, techniques named after their originators such as Maitland, Kaltenborn, Mulligan, and Cyriax, were not listed as independent concepts in SNOMED CT or OMOP CDM. Instead, they could be only represented through broader terms, such as joint mobilization. Such indirect representations failed to reflect important clinical characteristics, including the application method, type of mechanical input, and therapeutic intent, thereby significantly reducing semantic precision. Soft tissue techniques exhibited similar results such as Trigger Point Therapy, Fascial Manipulation, Cross Friction Massage, Active Release Technique, and Instrument-Assisted Soft Tissue Mobilization were not independently defined and were instead grouped under general concepts such as myofascial release or soft tissue mobilization. This lack of specificity made it difficult to distinguish technical differences and clinical significance among various approaches and ultimately hindered data structuring and interpretability. Meanwhile, nerve techniques such as Proprioceptive Neuromuscular Facilitation, Nerve Mobilization, and Neurodevelopmental Treatment were clearly defined in both SNOMED CT and OMOP CDM. However, more specific subtypes such as Bobath and

Table 2. Standardization of manual therapy techniques in SNOMED CT and OMOP CDM

Category	Technique name	SNOMED CT	OMOP CDM	Alternative concept
Orthopaedic	Accessory mobilization	Present	Present	
	Cyriax mobilization	Absent	Not mappable	Joint mobilization
	High-velocity low-amplitude	Present	Present	
	Kaltenborn technique	Absent	Not mappable	Joint mobilization
	Maitland technique	Absent	Not mappable	Joint mobilization
	Mobilization with movement	Absent	Not mappable	Joint mobilization
	Mulligan technique	Absent	Not mappable	Joint mobilization
	Muscle energy technique	Present	Present	
	Spinal manipulation	Present	Present	
	Thrust manipulation	Absent	Not mappable	Mobilization with impulse technique
Soft tissue	Active release technique	Absent	Not mappable	Soft tissue mobilization
	Connective tissue massage	Present	Present	
	Cross friction massage	Absent	Not mappable	Therapeutic massage
	Fascial manipulation	Absent	Not mappable	Myofascial release
	Instrument-assisted soft tissue mobilization	Absent	Not mappable	Soft tissue mobilization
	Lymphatic drainage massage	Present	Present	
	Myofascial release	Present	Present	
	Soft tissue mobilization	Present	Present	
	Trigger point therapy	Absent	Not mappable	Myofascial release
Nerve	Bobath therapy	Absent	Not mappable	Neurodevelopmental techniques
	Nerve mobilization	Present	Present	
	Neurodevelopmental treatment	Present	Present	
	Proprioceptive neuromuscular facilitation	Present	Present	
	Vojta therapy	Absent	Not mappable	Neurodevelopmental techniques
Others	Chiropractic therapy	Present	Present	
	Craniosacral therapy	Present	Present	
	Functional mobilization	Absent	Not mappable	Joint mobilization
	Osteopathic manipulative treatment	Present	Present	
	Visceral manipulation	Present	Present	

Vojta therapy were not individually defined and were represented only under broader categories like neurodevelopmental techniques. This categorical aggregation limited the ability to capture clinical distinctions among sub-techniques and reduced the precision of analysis. These inadequately defined or broadly grouped techniques reflect structural limitations within current terminology frameworks and pose significant challenges to precise clinical documentation, meaningful data standardization, and robust semantic interoperability in data-driven research.[21]

The underrepresentation of manual therapy techniques is in clear contrast to other clinical fields where active large-scale research is being conducted through terminology standardization. For example, drug-related data were

Table 3. Standardization rate of manual therapy techniques

Category	Total techniques	Standardized techniques	Standardization rate (%)	Confidence interval 95%
Orthopedic	10	4	40.0	16.8-68.7
Soft tissue	9	4	44.4	18.9-73.3
Nerve	5	3	60.0	23.1-88.2
Others	5	4	80.0	37.6-96.4
Total	29	15	51.7	34.4-68.6

comprehensively standardized in OMOP CDM using the RxNorm vocabulary and were used in various studies.[22–24] In the large population-based cohort study, over 130,000 patient-reported medication entries were processed, with 94% successfully mapped to RxNorm concepts and 85% further linked to structured drug classes, indicating high feasibility for large-scale automated normalization.[24] The GEMINI-RxNorm system, implemented across seven Canadian hospitals, achieved 99.6% automated standardization of more than 2 million inpatient medication orders, while maintaining high accuracy (recall $> 98.5\%$, F1-score > 0.90) and reducing manual review by up to 99.99%.[23] These cases highlight the robustness and scalability of RxNorm in supporting standardization of high-quality drug data. Furthermore, the conversion of approximately 50,000 prostate cancer registration records to OMOP CDM in Germany resulted in more than 99% successful mapping, demonstrating that large-scale structural standardization is feasible and effective in the disease domain.[25] Similarly, using the episode domain of OMOP CDM, the pulmonary hypertension registry data was modeled with 184,718 disease-curing episodes, confirming that 97-99% of records were successfully mapped, enabling standardized and structured analysis even in rare and chronic disease situations.[26] On the other hand, manual therapy techniques were not sufficiently integrated into international standardized clinical terms. Nearly half of these techniques are not individually defined within SNOMED CT or OMOP CDM, instead represented only by a broad level of concept, making it difficult to capture specific clinical evidence and accurately distinguish between techniques. This contrast is particularly pronounced given the widespread use of manual therapy in real-world clinical practice. According to the most recent CMS Physician/Supplier Procedure Summary (PSPS) dataset, CPT 97140 accounted for 331,118 submitted services, with approximately 315,678 allowed services and 6.51 million USD in allowed charges, ranking sixth among all HCPCS codes by service volume and representing 5.9%

of total submitted services.[27] These figures confirm that manual therapy is not a marginal intervention but a frequently delivered and reimbursed service. However, this utilization is captured only under a single umbrella code, which obscures the diversity of techniques. Thus, despite its high overall prevalence, the lack of granular terminology prevents the recognition of clinically meaningful distinctions and underscores the urgent need to establish more detailed standardized vocabularies for manual therapy techniques.

This study conducted the first structured investigation into how manual therapy techniques are represented within two internationally standardized clinical vocabulary, SNOMED CT and OMOP CDM. By categorizing 29 widely used manual therapy interventions into four clinical domains and examining their mapping status, the study found that nearly half are either absent from both vocabularies and can only be described using broad, non-specific categories. These gaps indicate that essential areas of physical therapy practice are not sufficiently captured within current digital health terms. This lack of semantic precision hinders accurate clinical documentation, limits data standardization, and poses challenges for AI-based modeling and applications in multicenter research, insurance billing systems, and rehabilitation medicine.[28] The results revealed that the need for targeted improvements in vocabulary infrastructure to better reflect the diversity and clinical specificity of manual treatment practices. By identifying these gaps and providing a systematic framework for terminology evaluation, the study will be able to provide basic knowledge for future standardization efforts and help to more effectively integrate physical therapy into the digital health ecosystem.

This study had several limitations. First, the study focused only on SNOMED CT and OMOP CDM; other standardized terminologies, such as ICD-10, CPT, and LOINC, were not included. Second, the classification of manual therapy techniques into four categories was based on expert judgment and literature review, which may vary

across clinical settings or geographic regions. Third, the terminology status was evaluated using the SNOMED CT and OMOP CDM based on searches conducted on July 24, 2025; future updates may alter the representation of certain techniques. Fourth, although inter-rater agreement was assessed and demonstrated substantial reliability, the clinical importance or frequency of use of each technique was not weighted because large-scale electronic medical record data were not analyzed. Fifth, no survey of physical therapists or physicians was conducted, and EMR records were not reviewed, which limits our understanding of how manual therapy is currently documented in real-world practice. Finally, the potential administrative burden or cost implications of expanding standardized vocabularies were not evaluated. Future research should include systematic reviews or database analyses to determine the actual prevalence of manual therapy documentation in EMRs, surveys of clinicians to capture documentation practices, and validation studies assessing whether terminology gaps affect clinical outcomes or research quality. In addition, cost–benefit analyses are needed to evaluate the feasibility of implementing more granular standardized vocabularies in routine practice.

CONCLUSION

This study investigated the extent to which 29 widely used manual therapy techniques in physical therapy clinical practice are defined and expressed in the international standard clinical terminology systems, SNOMED CT and OMOP CDM. Fourteen techniques, which account for half of the total techniques, were not defined as independent concepts in either of the two terminology systems, and only indirect expressions through higher concepts were found to be possible. It indicated that the therapeutic techniques in the field of physical therapy are still not sufficiently reflected within the standard clinical terminology system, which limits the structuring and use of manual therapy in electronic medical records, research databases, and artificial intelligence learning data. Accordingly, it is necessary to develop standard concepts and improve terms for manual therapy techniques unique to physical therapy, and conceptual integration within the international terminology system such as SNOMED CT and OMOP CDM will be needed.

Key Points

Question Are manual therapy techniques adequately represented in international standardized clinical terminology systems, such as SNOMED CT and OMOP CDM?

Findings Only 51.7% of the manual therapy techniques were formally defined, and the remainder were either absent or described only in generalized terms, indicating a lack of semantic precision.

Meaning Expanding standardized terminologies to encompass distinct manual therapy techniques is essential for accurate clinical documentation and effective data utilization.

Author contributions

Conceptualization: JH Kim.

Data acquisition: JH Kim.

Design of the work: JH Kim.

Data analysis: JH Kim.

Project administration: JH Kim.

Interpretation of data: JH Kim.

Writing – original draft: JH Kim.

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