



Digital and Telehealth-Enabled Occupational Therapy for Sustainable Rehabilitation: A Structured Evidence Review

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Abstract. Rehabilitation services are expected to serve more people, yet expansion cannot be considered separately from the environmental costs associated with travel, facilities, digital devices, and data infrastructure. This structured evidence review examined whether digital and telehealth-enabled occupational therapy (OT) can improve access while retaining clinical judgement and avoiding overstated sustainability claims. The review used bibliographically traceable evidence from PubMed/MEDLINE, the Cochrane Library, Google Scholar, occupational therapy and digital-health journals, WFOT publications, and Indonesian policy reports. Evidence was organised into five delivery modalities: synchronous video consultation, mobile health applications, virtual reality, artificial intelligence or wearable-supported monitoring, and hybrid care. The most consistent OT-specific support concerns video-based coaching, consultation, caregiver training, and follow-up. Virtual reality appears useful as an adjunct in selected stroke rehabilitation programmes, whereas AI and wearable technologies remain ahead of the controlled, OT-specific evidence required for routine practice. Across the literature, recurring implementation concerns include unstable connectivity, unequal digital capability, insufficient therapist preparation, privacy and documentation risks, and uncertain reimbursement. An illustrative Indonesian calculation indicates that replacing one clinic attendance with a remote session may avoid 3.0-33.0 kg of travel-related CO₂, depending on journey distance. This estimate deliberately excludes device manufacture, electricity use, data infrastructure, and electronic waste. The findings therefore support selective hybrid delivery rather than the assumption that telehealth is inherently sustainable. Progress in Indonesia will depend on OT-specific competencies, secure systems, viable reimbursement, and local studies that evaluate occupational outcomes, access, equity, cost, and carbon consequences within the same service pathway.

Keywords: Occupational Therapy; Telehealth; Digital Health; Sustainable Rehabilitation; Carbon Footprint; Clinical Reasoning; Indonesia.

1 Introduction

Demand for rehabilitation is rising for several reasons. Populations are ageing, non-communicable conditions are becoming more prevalent, and more people survive acute illness with ongoing functional needs. At the same time, health care is estimated to

contribute approximately 4.4% of global net emissions [1]. Expanding the existing delivery model without redesign would therefore increase both access and inefficiency: more journeys, heavier use of facilities, repeated appointments, and fragmented care pathways.

For occupational therapy, this tension is visible in ordinary clinical decisions. Knowing that a client struggles with bathing does not provide enough information to plan intervention. The therapist may need to observe the bathroom layout, the sequence the person actually follows, the supports within reach, and the way a caregiver assists [2]. A video consultation can expose details that may never emerge during a clinic appointment. However, it can also become ineffective or unsafe when the connection is unreliable, privacy is limited, or the client cannot manage the platform. Telehealth should therefore be selected because it fits the person, occupation, and environment—not simply because the technology is available.

The COVID-19 pandemic compressed years of service redesign into a short period. Many organisations began remote delivery before competency standards, staff preparation, and reliable workflows were established. In one large health system, weekly telehealth activity rose from several hundred consultations to several hundred thousand within a few months [3]. Occupational therapy services experienced a similar transition. Subsequent reviews have covered children, adults, neurological and chronic conditions, and community practice [4-6]. Even so, the evidence base remains uneven. Feasibility and satisfaction are reported frequently, while sustained occupational participation, long-term adherence, and equity receive much less attention.

A lower carbon footprint is plausible, but it should not be assumed. Telemedicine reviews consistently show that avoided travel can reduce transport-related emissions [15,17]. Remote care nevertheless relies on manufactured devices, electricity, data transmission, storage, replacement cycles, and eventual disposal [18]. Telehealth therefore redistributes part of the environmental burden rather than eliminating it. The relevant question is whether a specific OT pathway produces sufficient clinical and access value, and whether its total environmental cost is actually lower than the face-to-face alternative.

This review addresses that practical question. It differentiates the principal digital OT modalities, considers the clinical reasoning needed to use them safely, identifies implementation barriers that are likely to matter in Indonesia, and presents cautious travel-emission scenarios. Technology is treated as one component of service design, not as evidence of effectiveness in itself. Where the literature is limited, that limitation is stated explicitly.

2 Materials and Methods

A structured evidence review was selected because the literature is broad, methodologically diverse, and not suitable for a single pooled estimate. The approach was informed by scoping-review principles, although the work was not presented as a complete systematic review or a fully reported PRISMA-ScR study. The Population-Concept-Context framework was used to define the topic boundaries. PICO was applied only when a comparative intervention study could be interpreted more clearly through a conventional clinical question [19-21].

The search was designed to be traceable rather than exhaustive. Sources included PubMed/MEDLINE, the Cochrane Library, Google Scholar, the American Journal of Occupational Therapy, the Journal of Medical Internet Research, the International Journal of Telerehabilitation, WFOT publications, and Indonesian digital-health policy documents. Evidence was retained only when the full source could be accessed or its bibliographic identity could be verified. Publications from 2021 to 2026 were prioritised for substantive conclusions. Earlier sources were kept when they provided an established method, a professional definition, or essential historical context.

Searches began with occupational therapy and telehealth terms and were expanded to cover technology, policy, equity, and environmental impact. Combinations included occupational therapy, telehealth, telerehabilitation, telemedicine, digital health, mHealth, virtual reality, artificial intelligence, wearable sensors, remote rehabilitation, sustainable healthcare, carbon footprint, health equity, Indonesia, and low- and middle-income countries. A title alone was not considered sufficient evidence. Each citation had to be traceable through a DOI, PubMed record, publisher page, official institutional source, or accessible full text.

Table 1. Eligibility Criteria Using the PCC Framework

PCC element	Inclusion	Exclusion
Population	Clients receiving occupational therapy across the lifespan, caregivers involved in OT, and OT practitioners delivering digital or hybrid services.	Studies without an identifiable OT component, or studies using generic technology unrelated to rehabilitation participation.
Concept	Telehealth, telerehabilitation, video consultation, mHealth, virtual reality, artificial intelligence, wearable monitoring, remote coaching, and hybrid OT delivery.	Static assistive technology alone, purely software-engineering papers, editorials without evidence, and protocols without findings.
Context	Clinical, home, school, work, community, and primary-care settings in high- and low- or middle-income countries, with attention to policy evidence relevant to Indonesia.	Non-rehabilitation settings and sources that could not be bibliographically verified.

Table 2. Complementary PICO Structure for Comparative Evidence

Element	Operational definition in this review
Population	Individuals with neurological, developmental, chronic disease, musculoskeletal, mental health, or age-related functional limitations who receive OT or OT-relevant rehabilitation.
Intervention	Digital or telehealth-enabled OT, including video coaching, remote home programmes, mHealth self-management, virtual-reality task practice, wearable-assisted monitoring, or hybrid service delivery.

Element	Operational definition in this review
Comparator	Face-to-face OT, usual care, a lower-intensity intervention, waitlist, or an alternative digital modality, where available.
Outcome	Occupational performance, functional independence, ADL/IADL performance, participation, quality of life, satisfaction, adherence, cost, access, equity, and environmental impact.

2.1 Data Extraction and Synthesis

Information was extracted narratively rather than forcing dissimilar studies into one numerical summary. For each source, the review recorded the form of digital delivery, target population, outcomes, implementation barriers and facilitators, and any connection to sustainability. The evidence included systematic reviews, scoping reviews, pilot studies, randomised studies, and policy documents. These designs answer different questions and do not carry equal certainty. The synthesis therefore focused on areas of convergence, points of disagreement, and the boundaries of what each source could reasonably support.

The carbon calculation was intentionally narrow. For each scenario, the assumed return distance was multiplied by WRI Indonesia's passenger-vehicle factor of approximately 0.12-0.22 kg CO₂ per passenger-kilometre for a small-to-medium petrol vehicle [23]. The estimate includes only patient travel that could be avoided when a clinic visit is replaced by a remote session. Device manufacture, household electricity, platform operation, data-centre use, equipment replacement, and electronic waste were excluded. The resulting values should therefore be interpreted only as travel scenarios, not as life-cycle estimates or evidence of a positive overall carbon balance.

3 Results

Five distinct applications of digital technology emerged from the evidence, and they should not be treated as one intervention. Video consultation and hybrid delivery are closest to routine OT practice, although suitability still depends on the person, occupation, and level of risk. Mobile applications and virtual reality may strengthen a programme, but neither represents a complete OT service on its own. Artificial intelligence and wearable monitoring remain at an earlier stage. They may extend observation between appointments, but their data become clinically meaningful only when a therapist can interpret activity, context, safety, and occupational significance.

Table 3. Evidence Map by Digital OT Modality

Modality	Evidence signal	Clinical reasoning implication
Synchronous video consultation	Recent OT reviews describe this approach as feasible, acceptable, and comparable with face-to-face care for selected populations, particularly for coaching, education, self-management, and work conducted in the home context [4-6].	Appropriate when hands-on handling is not essential, the client or caregiver can operate the platform, safety risks are manageable, and viewing the home environment adds clinical value.
mHealth applications	Applications may support self-management, exercise reminders, education, and adherence, although clinical validation of many app-store products remains inconsistent [7].	Best used as a monitored adjunct rather than stand-alone OT, after goals, dose, feedback, privacy arrangements, and adherence monitoring have been defined.
Virtual reality	Cochrane evidence suggests modest improvement in upper-limb use and balance after stroke, mainly when virtual reality supplements conventional therapy rather than replaces it [10].	Most useful for repeated task practice, motivation, feedback, and graded motor challenge. It should complement, not replace, occupation-based goal setting.
AI and wearable sensors	These technologies have potential for activity recognition, remote monitoring, and personalised feedback, but controlled evidence specific to OT practice remains limited [11].	They should function as decision-support tools rather than independent decision-makers. Therapists must still interpret occupational meaning, context, safety, and ethical concerns.
Hybrid model	Combining remote coaching with selected face-to-face sessions aligns with post-pandemic service redesign and may reduce travel without removing hands-on assessment [4-6].	The most defensible model for Indonesia: in-person assessment and high-risk intervention, followed by telehealth for suitable follow-up, caregiver coaching, and home-programme monitoring.

3.1 Clinical Outcomes and Service Access

The strongest and most consistent use of OT telehealth is not an attempt to reproduce a clinic session remotely. Its clearest applications are coaching, education, self-management support, caregiver training, review of home programmes, and discussion of environmental barriers [4-6]. These activities depend primarily on observation, listening, collaborative problem-solving, and adaptation of routines, which often translate well to video. A pilot randomised trial involving rural parents of children with type 1 diabetes showed that occupation-based coaching could be delivered remotely [8]. A separate pilot involving older adults reported encouraging findings from a brief, individualised, occupation-centred lifestyle intervention [9]. Both studies are clinically relevant, but they remain pilot investigations and do not resolve questions about comparative effectiveness, durability, or implementation at scale.

There is no evidence base for making telehealth the automatic replacement for face-to-face OT. Direct examination, skilled handling, manual facilitation, close sensory-motor observation, and immediate risk management cannot always be transferred to a screen. The same limitation applies to high-risk transfers, unstable medical conditions,

substantial communication barriers, and homes that are unsafe or insufficiently private. The clinical decision is therefore not a generic choice between telehealth and face-to-face care. It is a judgement about which parts of an individual pathway can be managed remotely, which parts require physical attendance, and which findings should trigger an immediate return to in-person care.

3.2 Implementation Barriers and Facilitators

Implementation barriers rarely occur in isolation. A client may own a smartphone but have no private place to use it, or may have a stable connection but lack confidence in navigating the platform. A person may also be comfortable with technology yet have cognitive, sensory, or communication needs that make remote interaction unreliable. Therapists face a different cluster of pressures: limited preparation for tele-assessment, uncertainty about what can be judged safely through a screen, additional documentation, and disruption of established routines. At the service level, procurement, scheduling, platform security, technical support, and data protection each require dedicated systems. Policy ultimately determines whether telehealth is funded, governed, and subject to minimum standards. Without this structure, remote OT remains an improvised workaround rather than a dependable clinical pathway [12,13].

Indonesia's expanding digital-health policy environment should not be interpreted as evidence that OT telehealth is ready for routine implementation. Telemedicine is developing nationally [24], but requirements specific to OT competency, documentation, risk management, escalation, and reimbursement remain limited. In this gap, two therapists may provide apparently similar remote services while using different risk thresholds, recording different information, and making different decisions about face-to-face review. This variation is more than administrative inconsistency; it is a governance problem with direct implications for safety, equity, and outcome evaluation.

Table 4. Implementation Priorities for Indonesian Telehealth OT

Level	Priority action	Expected contribution
Client and caregiver	A brief digital-readiness screen, caregiver orientation, and a consent-and-privacy checklist.	Fewer failed sessions and stronger protection of safety, confidentiality, and engagement.
Therapist	Competency standards covering tele-assessment, remote coaching, documentation, risk screening, and escalation pathways.	Reduces weak clinical reasoning and inappropriate substitution of face-to-face care.
Service provider	A secure platform, scheduling workflow, documentation templates, IT support, and a hybrid triage protocol.	Maintains operational reliability instead of leaving individual therapists to improvise.
Policy and payer	An OT-specific telehealth tariff pathway and minimum service standards under JKN or comparable institutional payment systems.	Supports sustainable financing, clearer accountability, and data that can be evaluated.

3.3 Environmental Co-Benefit Scenarios

Environmental benefit depends on travel that is genuinely avoided. Telemedicine reviews report lower transport-related emissions, but the amount saved changes with distance, geography, vehicle type, occupancy, and assumptions about the digital system [15,17,18]. These factors vary considerably across Indonesia. A 25-km urban return trip, an 80-km rural journey, and travel involving inter-island transport represent very different burdens. Table 5 therefore provides illustrative scenarios rather than a national estimate, showing how strongly the result depends on the travel assumption used.

Table 5. Illustrative Travel-Related CO2 Avoided per Telehealth OT Session in Indonesia

Scenario	Assumed avoided round trip	Emission factor	Estimated travel CO2 avoided
Urban conservative	25 km	0.12-0.22 kg CO2/km	3.0-5.5 kg CO2
Urban upper scenario	40 km	0.12-0.22 kg CO2/km	4.8-8.8 kg CO2
Rural lower scenario	80 km	0.12-0.22 kg CO2/km	9.6-17.6 kg CO2
Rural upper scenario	150 km	0.12-0.22 kg CO2/km	18.0-33.0 kg CO2

Note. The figures represent avoided patient travel only and were calculated using WRI Indonesia passenger-vehicle emission factors [23]. They exclude device manufacture and replacement, household electricity, platform and data-centre energy, and electronic waste. Reporting these figures as net carbon savings would overstate the evidence.

4 Discussion

Digital OT is most valuable when it changes the organisation of care for a defined clinical purpose. The modalities in this review perform different functions. A video consultation may show how a client completes an actual household task. Virtual reality may provide repeated, graded motor practice. A wearable device may reveal patterns

of activity between appointments. Grouping all three under a broad telehealth label can obscure these differences and lead to inappropriate modality selection. The starting point should remain the occupational goal, followed by risk, required physical assistance, context, client capability, caregiver support, and the mechanism through which change is expected.

A hybrid pathway is the most credible option for Indonesia because it avoids the weakest assumptions at both extremes. Fully digital care would exclude people with poor connectivity and may be unsafe when skilled handling, complex examination, severe cognitive or sensory impairment, or an unsuitable home environment is involved. Conversely, an entirely face-to-face pathway maintains avoidable travel and restricts access for people who live far from services. A more defensible sequence is to use in-person contact for initial assessment, complex examination, and risk stratification, then transfer suitable goals to remote coaching, caregiver training, environmental review, and home-programme progression. The balance should change as the person's needs change rather than being fixed at referral.

The environmental argument remains provisional. Avoiding a long or frequently repeated journey may be meaningful for a family, but travel represents only one part of the overall footprint. Electricity sources, device lifespan, data storage, network infrastructure, replacement frequency, and electronic-waste disposal also matter, yet OT studies rarely measure them. Until complete service pathways are evaluated, green rehabilitation should be treated as a testable proposition supported by partial evidence—not as an inherent property of remote care.

A second risk is the presentation of telehealth as a cheaper substitute for therapists or rehabilitation infrastructure. Remote care still consumes professional time and requires preparation, secure systems, documentation, supervision, outcome measurement, technical support, and follow-up. Removing those inputs does not create efficiency; it produces a thinner service with less clinical control. The defensible policy position is that digital delivery can extend access when it is embedded in governance and competent clinical reasoning. It should not become a convenient label for underinvestment in the rehabilitation workforce.

4.1 Limitations

Several limitations should constrain interpretation. The review mapped accessible and verifiable sources but did not undertake the exhaustive database searching, duplicate screening, and complete PRISMA-ScR reporting expected of a formal scoping review. It also combined reviews, pilot trials, randomised studies, and policy documents. This breadth is useful for mapping the field, but it does not permit pooled effects or strong causal conclusions. Finally, the environmental calculation ended at patient travel. A credible Indonesian estimate would require observed journey data, transport mode and occupancy, platform energy, device replacement, and a life-cycle assessment of the full service pathway.

5 Conclusion

Digital and telehealth-enabled OT can contribute to sustainable rehabilitation only when delivery decisions are guided by clinical reasoning rather than enthusiasm for technology. Current evidence most strongly supports a hybrid model: face-to-face care for assessment, direct handling, safety-critical intervention, and complex judgement; and remote care for appropriate coaching, education, self-management, environmental consultation, caregiver support, and follow-up.

Indonesia has a plausible route forward, although the enabling infrastructure remains incomplete. OT-specific telehealth competencies, secure and interoperable records, workable reimbursement under JKN or similar arrangements, stronger primary-care connectivity, and prospective local research are all required. Future studies should examine occupational performance, access, equity, cost, service burden, and carbon consequences together. Measuring only one of these domains will continue to produce an incomplete account of sustainability. Until the wider pathway is established and evaluated, broad claims that digital OT is a green solution remain premature.

Acknowledgments. The author acknowledges the academic support provided by the Occupational Therapy Study Program, Vocational Education Program, Universitas Indonesia. AI-assisted tools were used during manuscript preparation for language refinement, structural checking, and formatting support. The author independently reviewed the cited evidence, revised the interpretation and wording, approved the final manuscript, and accepts responsibility for its content.

Disclosure of Interests. The author declares no competing interests relevant to this manuscript.

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