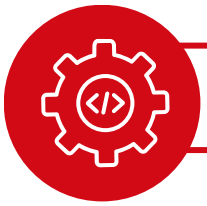
CIHR IRSC | Institute of Musculoskeletal Health and Arthritis
Institut de l'appareil locomoteur et de l'arthrite

Digital Health Pathway for Wearables

Learnings from the CIHR-IMHA Strengthening Workshop, May 2024

About the Themes

In the dynamic landscape of digital health, leveraging technology ethically and sustainably is fundamental to improve health outcomes for all Canadians.



HARDWARE & SOFTWARE

Developing hardware devices and software applications, and establishing the technological infrastructure required. This theme includes collecting, processing, and analyzing data generated by tracking devices (i.e., wearables), and integrating artificial intelligence.

SUB-POPULATIONS

Addressing the unique characteristics of specific sub-populations through measuring and analyzing demographic, behavioral, and health outcome data. Developing targeted interventions tailored to meet the specific needs of these groups.

POPULATION & PUBLIC HEALTH

Addressing the unique characteristics of specific sub-populations through measuring and analyzing demographic, behavioral, and health outcome data. Developing targeted interventions tailored to meet the specific needs of these groups.

ETHICS & EQUITY

Ensuring ethical considerations associated with the use of technology in healthcare and public health, and the protection of individuals' privacy rights in collecting, storing, and sharing health-related data. Enhancing digital accessibility to ensure that technology benefits all individuals.

IMPLEMENTATION

Implementing and sustaining technology-driven interventions in healthcare and public health settings. Ensuring fidelity to the intended intervention and addressing barriers to implementation for long-term sustainability.

Hardware & Software

Existing and developing technology lay the foundation for digital health

THE CURRENT LANDSCAPE
Existing Work

Various hardware and software tools have been developed to measure physical activity, from research-grade actigraphs to consumer-friendly wearables; and there is a growing trend towards real-world applications, employing methodologies like ecological momentary assessments, just-in-time adaptive interventions, and continuous 24-hour activity monitoring.

As artificial intelligence and machine learning evolve, we have begun to incorporate them into activity tracking systems to enhance accuracy and extract deeper insights. However, standardized protocols and validation studies are crucial to ensure data reliability and comparability across different platforms. Leveraging advanced technologies holds promise for promoting healthier lifestyles and personalized interventions.

THE CHALLENGES
Common Struggles

The cost and accessibility of wearables, along with challenges in raw data processing and logistical coordination for research in real-world settings, are some of the most common struggles in this field. These barriers are closely tied to the need for skill building among researchers.

Key challenges include keeping pace with the growing number of studies on wearable device reliability and validity. Moreover, the lack of coordination in addressing methodological challenges and standardizing data collection and analysis methods persists in physical activity research. Additionally, obstacles such as hyperparameter tuning and data availability constraints hinder the advancement of machine learning applications in health research.

THE GAPS
Missing Pieces

Software tools that efficiently process hardware data for behavioral interventions often lack user-friendly interfaces, posing a challenge for individuals without coding skills. Concerns surrounding data security and regulatory compliance, such as those outlined in the Health Insurance Portability and Accountability act, highlight the need for improved measures to safeguard sensitive information.

Uncertainty persists regarding the predictive capability of activity data for health outcomes, particularly cognitive function, signaling a need for further investigation. Additionally, the underrepresentation of low-income countries in current guidelines underscores a gap in understandings of health effects within diverse global contexts.

THE OPPORTUNITIES
Next Steps

The development of user-friendly platforms that process, analyze, and visualize wearable data, catering to individuals with varying levels of coding expertise, has been expressed as an opportunity for improvement. Additionally, there is potential for growth in refining Application Programming Interfaces (APIs) and data sharing protocols for research-grade devices, fostering easier integration into interventions.

Tailoring transparent and secure data storage practices to research needs is crucial. Moreover, collaborative efforts among researchers, institutions, and industry partners can identify applications for machine learning and bridge gaps in global representation, enriching our understanding of health behaviors and outcomes worldwide.

Sub-Populations

Digital tools enable individuals, spanning from athletes to patients, to monitor their health

THE CURRENT LANDSCAPE
Existing Work

Wearable technology and digital health tools have long supported individuals in achieving their health goals. However, wearable and digital health interventions, such as e-health technology and smartphone apps, are beginning to take on a more prominent role in clinical environments, be it for physical activity prescription or managing a health condition.

Additionally, there has been a rise in the development of physical activity prescription guidelines and increased interest in longitudinal studies in hopes of seeing more active living amongst Canadians.

THE CHALLENGES
Common Struggles

Technological limitations, such as affordability and tracking accuracy, and poor adherence to exercise programs hinder the advancement and adoption of digital interventions for physical activity. The validity of data collected from wearable devices and reliability of published guidelines continue to require improvements, thereby affecting the integration of wearable technology into treatments and the translation of guidelines into practice.

Additionally, clinicians may face time constraints in providing personalized support or motivational interviewing, which are essential for building trust and promoting behaviour change, without overmedicalizing physical activity.

THE GAPS
Missing Pieces

Evaluation on the real-world effectiveness of physical activity prescription interventions, particularly within specific clinical populations, remains a significant gap in research. Tailored interventions addressing diverse patient needs and preferences require further development and investigation, there is limited insight into the factors influencing adherence to exercise programs.

Furthermore, the need for personalized strategies is emphasized as the efficacy of existing exercise interventions in meeting individual preferences remains unclear.

THE OPPORTUNITIES
Next Steps

Interdisciplinary collaboration with diverse perspectives presents an opportunity to address challenges and develop effective interventions. Leveraging innovative technologies, like smartphone apps, can enhance intervention delivery and monitoring; while integrating human support alongside technology can enhance motivation and adherence to exercise interventions.

Additionally, conducting longitudinal studies to evaluate sustained health impacts and integrating insights from behavioral science can enhance intervention outcomes.

Population & Public Health

Wearable devices, whether commercial or research-grade, track population health trends

THE CURRENT LANDSCAPE
Existing Work

Canada has been tracking physical activity levels for several years through survey administration, namely via the Canadian Health Measures Survey (CHMS). With the increased availability and use of devices with tracking and measurement capabilities, studies are looking to supplement questionnaires and physical measurements by integrating health data from commercial devices, such as wearables. These tools help to inform movement behaviours across age groups and genders over time, as well as monitor health outcomes.

Moreover, consumer-grade technologies can be leveraged as interventions to promote physical activity.

THE CHALLENGES
Common Struggles

The management of logistics for device distribution, and standardization of protocols across studies is needed to ensure consistency and comparability of data remain key challenges.

The limited uptake of wearable devices in some populations may lead to biased datasets, and challenges in obtaining accurate data, due to issues like device loss, participant non-compliance, and technical difficulties, are prevalent.

THE GAPS
Missing Pieces

The various domains and forms of physical activity, such as active transportation, sleep, screen time, and strength training, within surveillance efforts lack consideration. The absence of comparative data complicates efforts to benchmark findings from Canada against those of other countries.

Additionally, standardized protocols, training manuals, and quality control procedures are needed to ensure the consistency and reliability of data across different collection sites and methodologies.

THE OPPORTUNITIES
Next Steps

The integration of wearables into large-scale longitudinal studies presents opportunities to enhance understanding of movement behaviors, aging trajectories, and the impact of interventions on healthy aging. Collaboration among experts in various fields offers opportunities to address methodological challenges and advance research on healthy aging.

Data collected through national surveillance and longitudinal studies can inform evidence-based policy and intervention strategies aimed at promoting physical activity and improving overall population health.

Ethics & Equity

Privacy and accessibility are key priorities as tech usage grows

THE CURRENT LANDSCAPE
Existing Work

Digital health technology has been lauded for its capacity to reach a large population. However, inclusive design practices in healthcare are imperative to ensure anyone, regardless of age, socioeconomic status, and capability, is able to reap the benefits. This takes into consideration accessibility measures, data security, and design implications which influence how users interact with digital health tools.

Furthermore, person-centered approaches, inclusive governance, and open science principles in health data design and utilization should be adopted when interacting with diverse knowledge systems.

THE CHALLENGES
Common Struggles

Barriers preventing underserved populations from accessing essential healthcare services are worsened by systemic issues such as educational inequity, geographical barriers, and active discrimination. Furthermore, the lived experiences from marginalized communities have been excluded in traditional evidence-based practices.

Challenges also arise in ensuring equity and inclusivity in research, including addressing biases in data collection and interpretation, as well as considering intersectionality in research design and analysis. There is resistance to challenging existing frameworks and methodologies in research and clinical practice, as well as limited avenues for the publication and dissemination of non-traditional forms of evidence.

THE GAPS
Missing Pieces

There is limited understanding of individual experiences and preferences, particularly among patients from marginalized communities. Inadequate frameworks for incorporating patient perspectives and co-designing interventions in healthcare research and practice, as well as the integration of digital health solutions into in-person care for underserved communities were identified as knowledge gaps.

There is a need for more comprehensive research on potential negative outcomes of technology-based tools, the impact of consumer-grade devices, and data on long-term effects of digital interventions. Moreover, further clarity on how individuals interact with wearable device data is needed to employ more equitable and inclusive designs.

THE OPPORTUNITIES
Next Steps

Collaborative, interdisciplinary efforts are vital in overcoming barriers to healthcare access for marginalized populations. Co-designing equitable digital health interventions and developing national strategies for health data governance in Canada require collaborations across research sectors. Advancing equity in research through addressing biases and promoting inclusivity is crucial, as is considering the benefits and potential unintended consequences of digital interventions.

Additionally, fostering digital literacy enables users to make informed decisions, complemented by rigorous research that supports evidence-based guidelines for ensuring equitable access. Through interdisciplinary collaboration, wearable technology and other digital health tools may be integrated into healthcare systems more effectively and holistically.

Implementation

Ensuring sustainability and fidelity in digital health tools fosters lasting behavioral changes

THE CURRENT LANDSCAPE
Existing Work

Implementation science draws from various disciplines and offers numerous theoretical frameworks applicable at different stages of the implementation journey. Research focuses on the affective computing and utilization of consumer technology, such as wearables and mobile applications, to promote physical activity and self-management among individuals with chronic conditions.

Additionally, peer support models and community-based approaches are being explored as potential touchpoints for digital interventions, especially for individuals with chronic diseases.

THE CHALLENGES
Common Struggles

Challenges include the complexity of determinants influencing implementation, measurement challenges in identifying these determinants, and sustaining implementation efforts over time.

Alongside understanding the barriers and facilitators influencing physical activity levels, bridging the gap between knowledge and practice in implementing physical activity guidelines in clinical settings poses an additional challenge.

THE GAPS
Missing Pieces

The lack of measurement tools for intangible factors, insufficient integration of qualitative methods into research and evaluation processes, and a gap in understanding and measuring interactions between individuals are some of the key barriers to implementing digital health interventions.

Understanding long-term engagement with digital interventions and determining the optimal timing and intensity of interventions are additional areas requiring further exploration.

THE OPPORTUNITIES
Next Steps

Opportunities include deepening understanding through qualitative research methods, applying theories like social cognitive theory to gain insights into implementation processes, and using implementation science to bridge the gap between knowledge and practice systematically.

As well, patient engagement, intervention co-design, and multilevel interventions are crucial for promoting physical activity and self-management behaviors among individuals with chronic conditions.

About the Strengthening Workshop

CIHR-IMHA is committed to supporting research in digital health and physical activity scale-up. Drawing on feedback from researchers and global experts—such as Dr. Emmanuel Stamatakis and Dr. Adrian Bauman from the University of Sydney, and Dr. Fiona Bull from the World Health Organization—CIHR-IMHA hosted a two-day workshop in Vancouver, British Columbia, in early May 2024.

This workshop provided a platform for a diverse group of individuals to discuss various topics related to digital tools and devices for health measurement, including physical activity. Through a series of information-sharing and discussion sessions, over 30 participants exchanged research findings and gained insights from experts across five key themes: Hardware & Software, Sub-Populations, Population & Public Health, Ethics & Equity, and Implementation Science. The insights and outcomes from these discussions are summarized in this document.

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The CIHR-IMHA team extends its gratitude to Dr. Stamatakis, the theme leads, and all attendees for their valuable contributions to the workshop.
















Recommended Resources

Click on the title to access the resources recommended by the workshop attendees.

Publications

Hardware & Software

Why Machine Learning (ML) has failed physical activity research and how we can improve

Systematic Review of the Reliability and Validity of Commercially Available Wearable Devices for Measuring Steps, Energy Expenditure, and Heart Rate

Predicting lying, sitting, walking, and running using Apple Watch and Fitbit data

Accuracy of Fitbit Devices: Systematic Review and Narrative Syntheses of Quantitative Data

Move more, move better: A narrative review of wearable technologies and their application to precision health

Multimodal biomedical AI

BenchMD: A Benchmark for Unified Learning on Medical Images and Sensors

Assessing real-world gait with digital technology? Validation, insights and recommendations from the Mobilise-D consortium

Sub-Populations

Connecting real-world digital mobility assessment to clinical outcomes for regulatory and clinical endorsement–the Mobilise-D study protocol

Monitoring mobility in older adults using a Global Positioning System (GPS) smartwatch and accelerometer: A validation study

Digitisation of emergency medicine: opportunities, examples and issues for consideration

Real-time virtual supports improving health equity and access in British Columbia

From Today to Tomorrow: Leveraging Digital Health to Move toward Health for All

Early mobility after fragility hip fracture: a mixed methods embedded case study

Rehabilitation Treatment Specification System: Methodology to Identify and Describe Unique Targets and Ingredients

Advancing Stroke Recovery Through Improved Articulation of Nonpharmacological Intervention Dose

Association of wearable device-measured vigorous intermittent lifestyle physical activity with mortality

Brief bouts of device-measured intermittent lifestyle physical activity and its association with major adverse cardiovascular events and mortality in people who do not exercise: a prospective cohort study

Effects of 12 Weeks of At-Home, Application-Based Exercise on Health Care Workers' Depressive Symptoms, Burnout, and Absenteeism: A Randomized Clinical Trial

COVID-19 Pandemic and Exercise (COPE) trial: a multigroup pragmatic randomised controlled trial examining effects of app-based at-home exercise programs on depressive symptoms

Recommended Resources

Population & Public Health

How can global physical activity surveillance adapt to evolving physical activity guidelines? Needs, challenges and future directions

Effectiveness of wearable activity trackers to increase physical activity and improve health: a systematic review of systematic reviews and meta-analyses

Are we ready for wearable-based global physical activity surveillance?

Device-measured physical activity and cardiometabolic health: the Prospective Physical Activity, Sitting, and Sleep (ProPASS) consortium

Top 10 International Priorities for Physical Fitness Research and Surveillance Among Children and Adolescents: A Twin-Panel Delphi Study

Prioritizing a research agenda on built environments and physical activity: a twin panel Delphi consensus process with researchers and knowledge users

Ethical & Equity Considerations

Essential Digital Health for the Underserved

The Disappearance of the Sick-Man from Medical Cosmology, 1770-1870

Designing and tool to support patient and public involvement in research project: the Involvement Matrix

Participation of people living with disabilities in physical activity: a global perspective

Training wicked scientists for a world of wicked complex problems

Reflections on patient engagement by patient partners: how it can go wrong

Learning from 'lived expertise': engaging athletes and patients in sport and exercise medicine research and policy

Implementation Science & Behaviour Change

Implementation science: What is it and why should I care?

Making implementation science more real

Implementation science made too simple: a teaching tool

The Updated Consolidated Framework for Implementation Research Based on User Feedback

Long-term usage of a commercial mHealth app: A "multiple-lives" perspective

How should family physicians provide physical activity advice? Qualitative study to inform the design of an e-health intervention

An Evaluation of a Commercialized mHealth Intervention to Promote Physical Activity in the Workplace

Commercial app use linked with sustained physical activity in two Canadian provinces: a 12-month quasi-experimental study

What we know about the actual implementation process of public physical activity policies: results from a scoping review

Effectiveness of physical activity promotion interventions in primary care: A review of reviews

Recommended Resources

Other

Guidelines

WHO Guidelines on Physical Activity and Sedentary Behaviour

Canadian 24-Hour Movement Guidelines

WHO Recommendations on digital interventions for health system strengthening

Tools

CIHR-IMHA Patient Engagement Training Modules

Institute for Better Health Learning Health Systems (LHS)

Sport Data Makerspace

Pathverse

Reports & Blogs

Interoperability Saves L:ives

The Politics of Pain

No Health, No Care: The Big Fat Loophole in the Hippocratic Oath