

# ATTIVITÀ SCIENTIFICA E DI RICERCA

BIENNIO 2017 - 2018

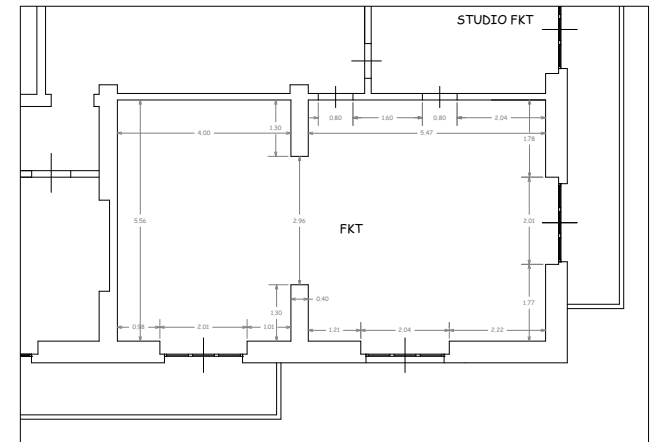
*Matteo Zago, PhD*

Coordinatori della ricerca: Dott. Eugenio Guffanti, INRCA Casatenovo  
Prof.ssa Manuela Galli, Politecnico di Milano



**Gennaio 2017**  
**Il punto di partenza**

**Laboratorio di analisi del movimento**  
**INRCA Casatenovo**  
**pianta e situazione iniziale**



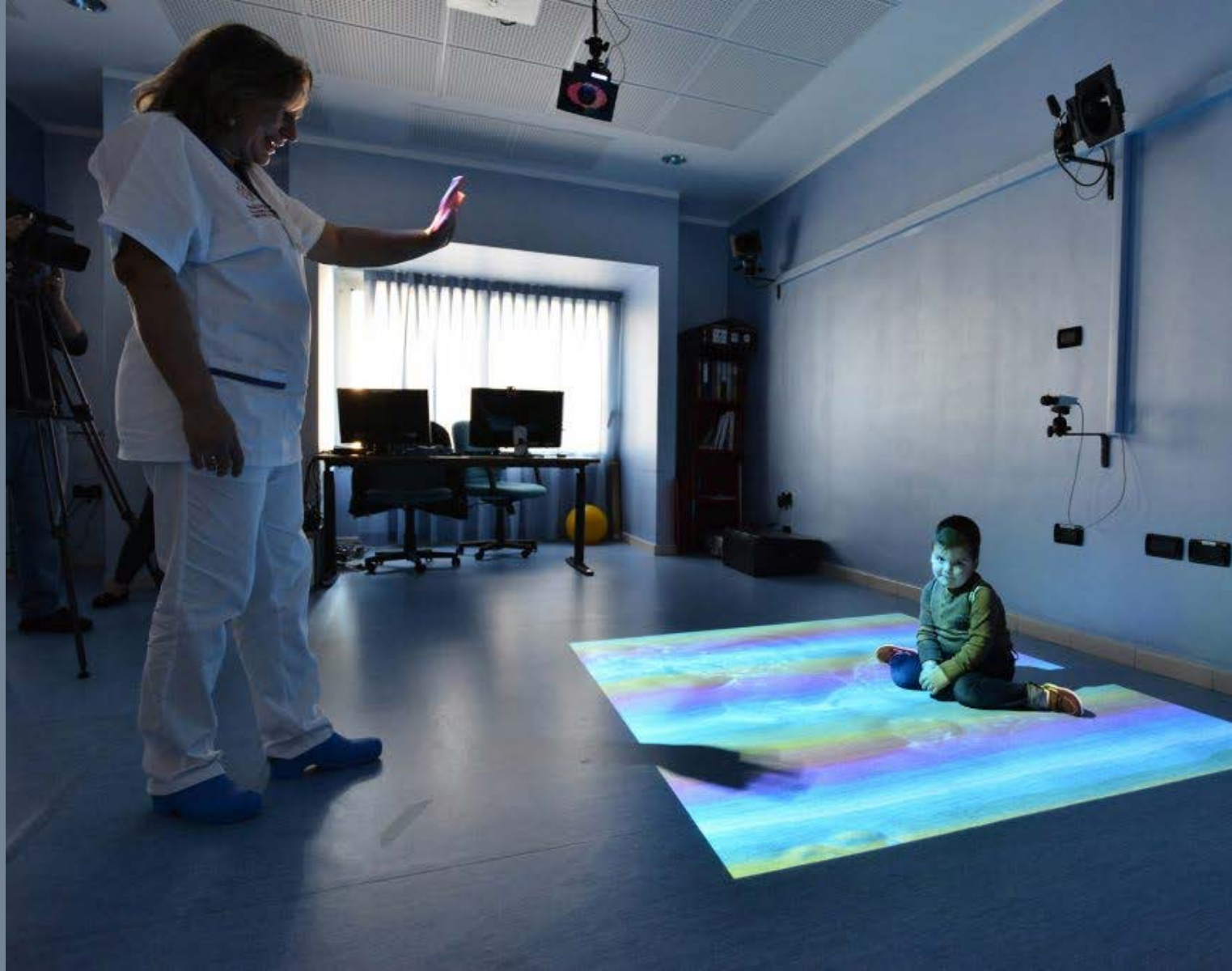
# Strumentazione acquisita con finanziamento Fondazione Serpero

- Sistema optoelettronico di analisi del movimento
- Piattaforme di forza
- Attività muscolare



# Strumentazione acquisita con finanziamento Fondazione Serpero

- Sistema di riabilitazione in realtà immersive BTS Nirvana



Aprile 2018

Avanzamento  
lavori



Aprile 2018

Avanzamento  
lavori



# Publicazioni scientifiche

5

articoli pubblicati su  
riviste scientifiche  
internazionali con  
affiliazione **Fondazione  
Filippo Serpero**

7

articoli internazionali in  
fase di **revisione** con  
affiliazione **Fondazione  
Filippo Serpero**

# Analisi della funzionalità del cammino in pazienti con broncopneumopatia cronica ostruttiva

- stato dell'arte della conoscenza
- definizione nuove linee di ricerca



POLITECNICO  
MILANO 1863





# Utilizzo di sensori indossabili per l'analisi del cammino in pazienti con Parkinson

- la tecnologia *wearable* attuale consente di determinare con buona precisione le caratteristiche generali del cammino



POLITECNICO  
MILANO 1863



## Gait evaluation using inertial measurement units in subjects with Parkinson's disease

Matteo Zago<sup>a,b</sup>, Chiarella Sforza<sup>c,d</sup>, Ilaria Pacifici<sup>a,c</sup>, Veronica Cimolin<sup>a</sup>, Filippo Camerota<sup>e</sup>, Claudia Celletti<sup>f</sup>, Claudia Condoluci<sup>f</sup>, Maria Francesca De Pandis<sup>g</sup>, Manuela Galli<sup>h,\*</sup>

<sup>a</sup> Department of Electronics, Information, and Bioengineering, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, MI, Italy

<sup>b</sup> Fondazione Istituto Farmacologico Filippo Segrate Viale Luigi, Majno 40, 20122 Milano, Italy

<sup>c</sup> Department of Biomedical Sciences for Health, Università degli Studi di Milano, via Mangiagalli 31, 20133 Milan, MI, Italy

<sup>d</sup> Institute of Molecular Biomedicine and Physiology, National Research Council, via Fratelli Cervi, 20090 Segrate, MI, Italy

<sup>e</sup> Università degli Studi di Roma "La Sapienza", Piazzale Aldo Moro 5, 00185 Rome, RM, Italy

<sup>f</sup> IRCCS San Raffaele Pisano, Via della Pisana, Tourinvest Sanità, Rome, Italy

<sup>g</sup> San Raffaele Cassino, Tourinvest Sanità, Via Gortano di Busio, 218, 03043 Cassino, FR, Italy

### ARTICLE INFO

#### Keywords:

IMU  
Wearables  
Optoelectronic motion capture  
Gait parameters  
Gait analysis

### ABSTRACT

We investigated whether a wearable system based on a commercial Inertial Measurement Unit (IMU) can reliably provide the main spatiotemporal gait parameters in subjects with Parkinson's disease (PD), compared to a gold-standard optoelectronic motion capture system.

The gait of 22 subjects with PD (Age: 69.4 (6.1) years; UPDRS-III: 28.0 (9.2)) was recorded simultaneously with an optoelectronic system and a commercial IMU-based wearable system. Eight spatiotemporal parameters describing the step cycle (cadence, velocity, stride length, stride duration, step length, stance, swing and double support duration) were compared between the two systems. The IMU and the optical system reported comparable gait parameters, with the exception of walking velocity (optical system, 0.72 (0.27)  $\text{ms}^{-1}$  vs. IMU: 0.86 (0.26)  $\text{ms}^{-1}$ ,  $p < 0.05$ ). Although most parameters detected by the two systems were not statistically different, some of them like stride length, double support and step duration showed notable root mean square and mean absolute errors. In conclusion, the algorithm embedded in the current release of the commercial IMU requires further improvements to be properly used with subjects with PD. Overall, the IMU system was sufficiently accurate in the assessment of fundamental gait spatiotemporal parameters. The fast and simplified data recording process allowed by wearables makes this technology appealing and represents a possible solution for the quantification of gait in the clinical context, especially when using a traditional 3D optoelectronic gait analysis is not possible, and when subjects are not fully cooperative.

# Utilizzo di pedane vibranti per il trattamento di pazienti obesi

- la *whole-body-vibration* è una terapia promettente, nelle donne soprattutto, ma necessita di ulteriore standardizzazione



POLITECNICO  
MILANO 1863

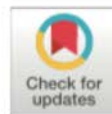
RESEARCH ARTICLE

## Whole-body vibration training in obese subjects: A systematic review

Matteo Zago<sup>1,2\*</sup>, Paolo Capodaglio<sup>3</sup>, Cristina Ferrario<sup>1,4</sup>, Marco Tarabini<sup>4</sup>, Manuela Galli<sup>1</sup>

**1** Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milano-Italy, **2** **Fondazione Istituto Farmacologico "Filippo Serpero", Milano-Italy**, **3** Research Laboratory in Biomechanics and Rehabilitation, Orthopedic Rehabilitation Unit, IRCCS Istituto Auxologico Italiano, Ospedale San Giuseppe, Piancavallo (VCO), Italy, **4** Dipartimento di Meccanica, Politecnico di Milano, Milano-Italy

\* [matteo2.zago@polimi.it](mailto:matteo2.zago@polimi.it)



### Abstract

#### Objective

(i) to determine the outcomes of whole-body vibration training (WBVT) on obese individuals, and the intervention settings producing such effects; (ii) identify potential improper or harmful use of WBVT.

#### Design

Systematic review.

#### Data sources

Medline, Scopus, Web of Science, PEDro and Scielo until July 2018.

#### Eligibility criteria

Full papers evaluating the effect of WBVT on body composition, cardiovascular status and functional performance in obese adults. Papers with PEDro score < 4 were excluded.

#### Study appraisal and synthesis

#### OPEN ACCESS

**Citation:** Zago M, Capodaglio P, Ferrario C, Tarabini M, Galli M (2018) Whole-body vibration training in obese subjects: A systematic review. PLoS ONE 13(9): e0202866. <https://doi.org/10.1371/journal.pone.0202866>

**Editor:** Slavko Rogan, Berner Fachhochschule, SWITZERLAND

**Received:** May 28, 2018

**Accepted:** August 12, 2018

**Published:** September 5, 2018

**Copyright:** © 2018 Zago et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

# Differenze di genere nella cinematica del cammino in pazienti con Sindrome di Down

- la funzionalità della locomozione è più compromessa nelle donne con Sindrome di Down, fattore da considerare nel percorso riabilitativo



POLITECNICO  
MILANO 1863

## *Gross gender differences in the gait kinematics of patients with Down Syndrome: a preliminary report*

Article #ID 118134 **accepted for publication** in Journal of Rehabilitation Medicine on November 1<sup>st</sup>, 2019.

### **Authors**

Matteo Zago, corresponding author  
Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano  
Piazza Leonardo da Vinci 32, 20133 Milano – Italy

Fondazione Istituto Farmacologico Filippo Serpero  
Viale Luigi Majno 40, 20122 Milano - Italy

email: [matteo2.zago@polimi.it](mailto:matteo2.zago@polimi.it)

Phone: +39 02 2399 3351

orcid: 0000-0002-0649-3665

Claudia Condoluci  
IRCCS San Raffaele Pisana, Tosinvest Sanità  
Via della Pisana 235, 00163 Roma – Italy  
email: [claudia.condoluci@sanraffaele.it](mailto:claudia.condoluci@sanraffaele.it)

Massimiliano Pau  
Department of Mechanical, Chemical and Materials Engineering,  
Università di Cagliari, Cagliari – Italy  
email: [massimiliano.pau@dimcm.unica.it](mailto:massimiliano.pau@dimcm.unica.it)  
orcid: 0000-0001-9835-3629

Manuela Galli  
Dept. of Electronics, Information and Bioengineering (DEIB), Politecnico di Milano

# Differenze di genere nella cinematica del cammino in pazienti con Sindrome di Down / 2

- Le differenze di genere più marcate si trovano nella cinematica articolare, piuttosto che nei parametri spatio-temporali del cammino



POLITECNICO  
MILANO 1863

JIDR

Journal of Intellectual Disability Research

Published on behalf of mencent and in association with IASSID

Journal of Intellectual Disability Research

doi: 10.1111/jir.12560

## Men and women with Down syndrome exhibit different kinematic (but not spatio-temporal) gait patterns

M. Pau<sup>1</sup>, C. Condoluci<sup>2</sup>, M. Zago<sup>3,4</sup>, M. Galli<sup>2,3</sup>

<sup>1</sup> Department of Mechanical, Chemical and Materials Engineering, University of Cagliari, Cagliari, Italy

<sup>2</sup> Department of Rehabilitation of Pediatrics and Developmental Disabilities, IRCCS San Raffaele Pisana, Rome, Italy

<sup>3</sup> Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy

<sup>4</sup> Fondazione Istituto Farmacologico Filippo Serpero, Milano, Italy

### Abstract

**Background** Gait phenotypes are well documented in people with Down syndrome (pwDS), but sex-related differences are still unexplored. This study investigated the existence of possible differences in spatio-temporal and kinematic parameters of gait between men and women with DS using quantitative three-dimensional gait analysis.

**Methods** Gait patterns of 117 pwDS (53 F, 64 M) who underwent a computerised gait analysis from 2008 to 2015 were retrospectively analysed to obtain

differences between men and women with DS were found concerning ankle dorsi-plantar-flexion or in all spatio-temporal parameters normalised by individuals' anthropometry, excluding cadence (higher in women).

**Conclusions** The findings of the present study highlight the need to investigate gait dysfunctions in pwDS by taking their sex into consideration. Such an approach may be useful not only in gaining a better understanding of the pathophysiology of gait disturbances associated with DS but also in

# Articoli in revisione con affiliazione Fondazione Serpero

1 *Identifying optimal body shape associated with strength outcomes in young Italian children according to place of residence: an allometric approach* (Human Movement Science)

*Educational impact of hand motion analysis in the evaluation of fast examination skills* (European Journal of Trauma and Emergency Surgery)

3 *Ultrasonographic and myotonometry evaluation of the shoulder girdle after isokinetic muscle fatigue protocol* (Journal of Orthopaedic and Sports Physical Therapy)

*Fatigue alters turns kinematics while running* (European Journal of Sports Science)

5 *PManalyzer: a Software for Whole-Body Movement Pattern Analysis Based on a Principal Component Decomposition of Kinematic Data* (Frontiers in Neuroinformatics)

*Gait and Postural Control Patterns in Down Syndrome: A Systematic Review* (Journal of NeuroEngineering)

7 *Kinetic-based indexes for the functional evaluation of gait in diplegic children: a preliminary report* (Computer Methods in Biomechanics and Biomedical Engineering)

# Dove siamo oggi



know-how  
sperimentale e  
biomeccanico



laboratorio  
di valutazione  
funzionale



produzione  
scientifica  
promossa dalla  
Fondazione

valutazione e  
ottimizzazione  
percorsi riabilitativi  
e miglioramento  
qualità di vita dei  
pazienti



Cosa abbiamo...



strumentazione di laboratorio

...su quali **risorse** puntare  
per il prossimo **triennio**



Ing. Matteo Zago, PhD