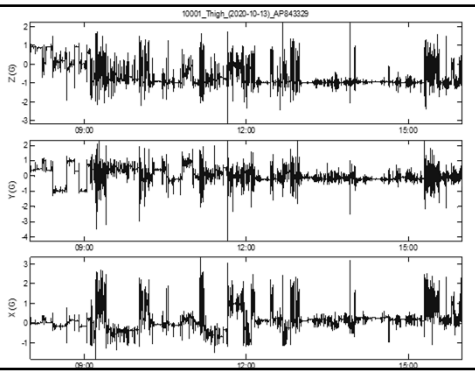
Laboratório de Cinesiologia Clínica e Ocupacional
Departamento de Fisioterapia

Comportamentos físicos medidos através de acelerometria: coleta, processamento e análise de dados

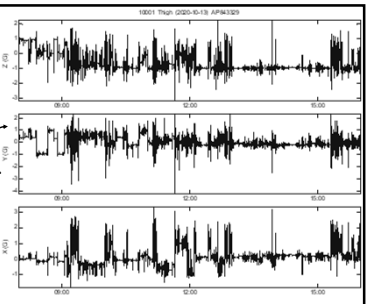
Profª. Drª. Ana Beatriz de Oliveira
Discente: Luiz Augusto Brusaca

23-Out-2024



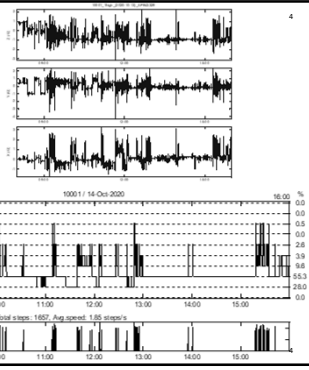
2

Agora, como passamos disso ...



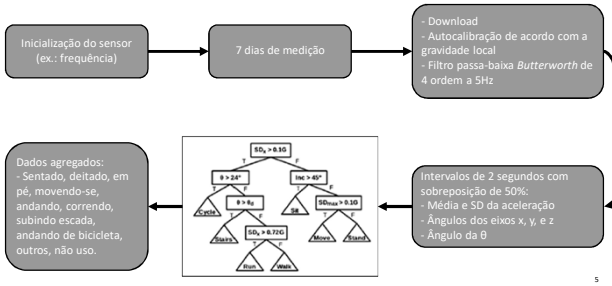
3

Agora, como passamos disso para algo compreensível?



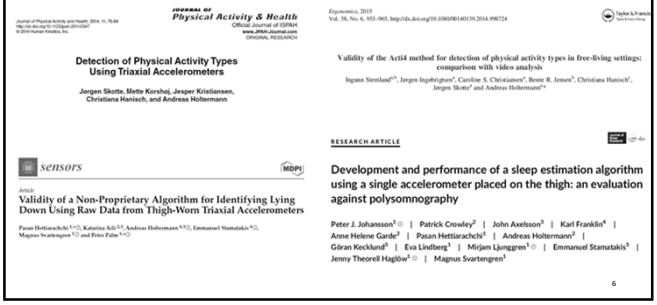
4

Exemplo de como usando o *software* Acti4/ActiPASS



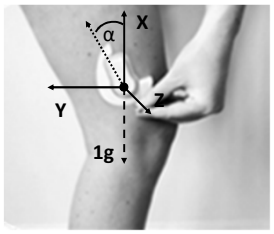
5

Validação do *software* Acti4/ActiPASS



6

Sentado *vs.* Em pé



$$Em\ pé = \arctan\left(\frac{Y^2 + Z^2}{X}\right)$$

$$Em\ pé = \arctan\left(\frac{0^2 + 0^2}{-1}\right)$$

$$Em\ pé = 0°$$

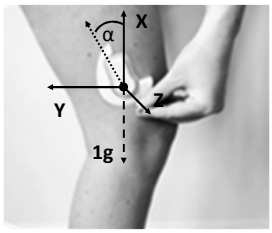
$$Sentado = \arctan\left(\frac{Y^2 + Z^2}{X}\right)$$

$$Sentado = \arctan\left(\frac{1^2 + 0^2}{0.001}\right)$$

$$Sentado = 90°$$

7

Ainda sentado?



$$? = \arctan\left(\frac{Y^2 + Z^2}{X}\right)$$

$$? = \arctan\left(\frac{0.8^2 + 0.1^2}{0.6}\right)$$

$$? = 47.3°$$

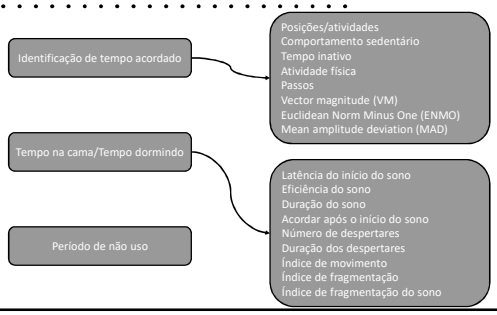
8

Sentado?

$> 45°$

9

Algoritmos



10

Tempo de uso (acordado) e não uso

Validation of Accelerometer Wear and Nonwear Time Classification Algorithm

LEENA CHOI[1,2], ZHOUWEN LIU[1,2], CHARLES E. MATTHEWS[3], and MACIEJ S. BUCHOWSKI[2,4]

Assessment of Wear/Nonwear Time Classification Algorithms for Triaxial Accelerometer

LEENA CHOI[1], SUZANNE CAPEN WARD[2], JOHN F. SCHNELLE[2,4], and MACIEJ S. BUCHOWSKI[2]

Identifying adults' valid waking wear time by automated estimation in activPAL data collected with a 24 h wear protocol

Elisabeth A H Winkler[1], Danielle H Bodicoat[2,3], Genevieve N Healy[1,4,5], Kishan Bakrania[2,3], Thomas Yates[2,3], Neville Owen[1,4A,6,11], David W Dunstan[1,2A,7,8,9,11,12] and Charlotte L Edwardson[2,3]

RESEARCH ARTICLE Open Access

A comparison of 10 accelerometer non-wear time criteria and logbooks in children

Bivind Aadland[1*], Lars Bo Andersen[1], Sigmund Alfred Anderssen[1,2] and Geir Kåre Resaland[1]

Assessment of Differing Definitions of Accelerometer Nonwear Time

Kelly R. Evenson and James W. Terry, Jr.

Identifying sedentary time using automated estimates of accelerometer wear time

Elisabeth A H Winkler,[1] Paul A Gardiner,[1] Bronwyn K Clark,[1] Charles E Matthews,[2] Neville Owen,[1,3] Genevieve N Healy[1,3]

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Tempo na cama/Tempo dormindo

RESEARCH ARTICLE

Development and performance of a sleep estimation algorithm using a single accelerometer placed on the thigh: an evaluation against polysomnography

Peter J. Johansson[1] | Patrick Crowley[2] | John Axelsson[3] | Karl Franklin[4] | Anne Helene Garde[2] | Pasan Hettiarachchi[5] | Andreas Holtermann[2] | Göran Kecklund[3] | Eva Lindberg[3] | Mirjam Ljunggren[1] | Emmanuel Stamatakis[5] | Jenny Theorell Haglöw[3] | Magnus Svartengren[3]

Review

Wearable Light-and-Motion Dataloggers for Sleep/Wake Research: A Review

Konstantin V. Danilenko[1], Oliver Stefani[2,3], Kirill A. Voronin[4], Marina S. Mezhakova[4], Ivan M. Petrov[4], Mikhail F. Borisenkov[4], Aleksandr A. Markov[4] and Denis G. Gubin[2,4,5,6]

Fully automated waist-worn accelerometer algorithm for detecting children's sleep-period time separate from 24-h physical activity or sedentary behaviors

Catrine Tudor-Locke, Tiago V. Barreira, John M. Schuna, Jr., Emily F. Mire, and Peter T. Katzmarzyk

Ambulatory sleep scoring using accelerometers—distinguishing between nonwear and sleep/wake states

Amna Barouni[1], Jörg Ottenbacher[1], Johannes Schneider[1], Bernd Feige[1], Dieter Riemann[1], Anne Herlan[1], Driss El Hardouz[1] and Darren McLennan[1]

OPEN **Sleep classification from wrist-worn accelerometer data using random forests**

Kalaivani Sundararajan[1], Sonja Georgievska[1], Bart H. W. te Lindert[2], Philip R. Gehrman[3], Jennifer Ramautar[2], Diego R. Mazzotti[2], Séverine Sabia[4,5], Michael N. Weedon[1], Eus J. W. van Someren[2], Lars Klösterl[6], Ilan Wang[6] & Vincent T. van Hees[6,7]

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Variáveis e modelos

Counts (por seg/min)
Vector magnitude (VM)
Euclidean Norm Minus One (ENMO)
Mean amplitude deviation (MAD)
Accelerometer Activity Index (AAI)
Monitor-Independent Movement Summary (MIMS)
Vibration
Aceleração do eixo x, y, z
Coeficiente de variação dos eixos x, y, z
Ângulos dos eixos x, y, z
Inclination velocity
Generalized velocity
…
Entre outras

Linear regression
Decision tree
Random Forest classifier
eXtreme Gradient Boosting classifier (XGBoost)
Hidden Markov Model (HMM)
Convolutional Neural Network (CNN)
Temporal Convolutional Network (TCN)
…
Entre outras

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Quadril *vs.* Coxa?

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Quadril *vs.* Coxa?

Light-intensity physical activity derived from count or activity types is differently associated with adiposity markers

Charlotte Lund Rasmussen[1,2] | Melker Staffan Johansson[3] | Patrick Crowley[1] | Peter Fjeldstad Hendriksen[1] | Jørgen Skotte[1] | Nidhi Gupta[1] | Andreas Holtermann[1,3]

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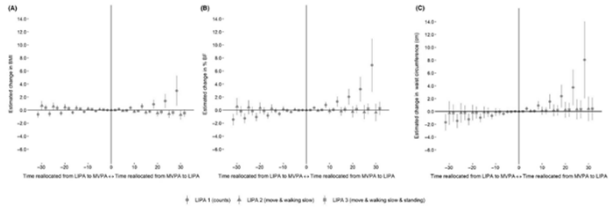
Quadril *vs.* Coxa?



Rasmussen, et al. Scand J Med Sci Sports (2020)

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Punho *vs.* Coxa? (tempo na cama)

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Punho *vs.* Coxa? (tempo na cama)

Comparison of activPAL and Actiwatch for Estimations of Time in Bed in Free-Living Adults

Mary C. Hidde,[1] Kate Lyden,[2] Josiane L. Broussard,[3,4] Kim L. Henry,[5] Julia L. Sharp,[6] Elizabeth A. Thomas,[4,7,8] Corey A. Rynders,[9,10] and Heather J. Leach[3]

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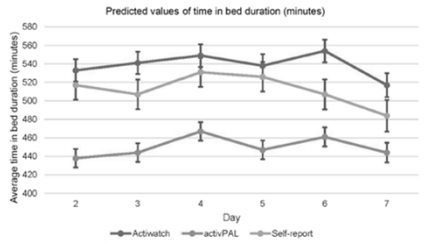
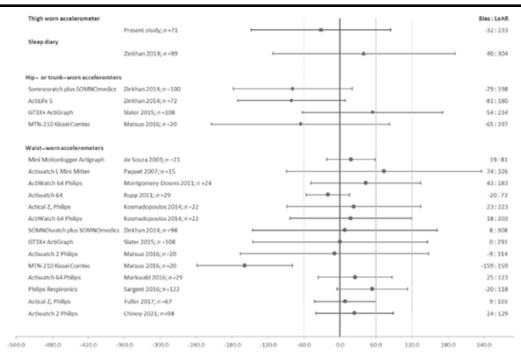
Punho *vs.* Coxa? (tempo na cama)



Hidde, et al. JMPB (2022)



Johansson, et al. J Sleep Res. (2022)

Punho *vs.* Coxa? (tempo sedentário)

Punho *vs.* Coxa? (tempo sedentário)

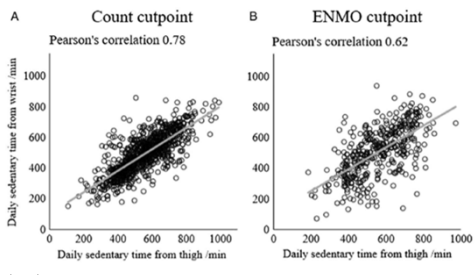
Comparison of Sedentary Time Between Thigh-Worn and Wrist-Worn Accelerometers

in Journal for the Measurement of Physical Behaviour

Click name to view affiliation

Kristin Suorsa *, Anna Pulakka *, Tuija Leskinen *, Jaana Pentti *, Andreas Holtermann *, Olli J. Heinonen *, Juha Sunikka *, Jussi Vahtera *, and Sari Stenholm *

Punho *vs.* Coxa? (tempo sedentário)



Suorsa, et al. JMPB (2020)

Mesma configuração, mas *software* diferente

Mesma configuração, mas *software* diferente

nature > scientific reports > articles > article

Article | Open access | Published: 18 February 2023

Comparison of different software for processing physical activity measurements with accelerometry

Sanne Verhoog, Cédric Gubelmann, Arjola Bano, Taulant Muka, Oscar H. Franco & Pedro Marques-Vidal

	GENEActiv MACRO[2]	Pampro[34] §	GGIR-White[7]	GGIR-MRC v.1.4–9 *	GGIR-MRC v.4.0.3 *
Thresholds for sedentary	< 241 g.min	< 48 mg	< 85 mg	< 48 mg	< 48 mg
Light	241–338 g.min	48–154 mg	85–181 mg	48–154 mg	48–154 mg
Moderate	339–1131 g.min	154–389 mg	182–436 mg	154–389 mg	154–389 mg
Vigorous	≥ 1132 g.min	≥ 389 mg	≥ 437 mg	≥ 389 mg	≥ 389 mg

	GENEACTIV	PAMPRO	GGIR-White	GGIR-MRC, v. 1.5–9	GGIR-MRC, v. 1.11–1
As time (min/day)					
SB	647 [567; 722]	1147 [1101;1192]	742 [701; 787]	633 [580; 681]	609 [554; 662]
Light PA	108 [85; 132]	177 [152; 201]	93 [67; 125]	196 [150; 245]	211 [166; 261]
Moderate PA	161 [114; 223]	88 [72; 106]	19 [11; 32]	31 [18; 47]	34 [20; 51]
Vigorous PA	1 [0; 5]	26 [19; 35]	1 [0; 3.]	2 [1; 4]	2 [1; 5]
As % of time					
SB	70.3 [62.1; 77.1]	79.7 [76.5; 82.8]	86.6 [81.9; 90.5]	73.5 [66.7; 79.2]	73.5 [66.7; 79.2]
Light PA	11.5 [9.3; 13.9]	12.3 [10.6; 13.9]	10.6 [7.8; 14.2]	22.5 [17.7; 27.4]	24.5 [19.7; 29.6]
Moderate PA	17.2 [12.4; 23.8]	6.1 [5.0; 7.4]	2.2 [1.3; 3.6]	3.5 [2.1; 5.4]	3.8 [2.4; 5.8]
Vigorous PA	0.1 [0; 0.5]	1.8 [1.3; 2.4]	0.1 [0.1; 0.3]	0.2 [0.1; 0.5]	0.2 [0.1; 0.5]

Mesmo dado, mas *cut-point* diferente

Mesmo dado, mas *cut-point* diferente

Comparability of published cut-points for the assessment of physical activity: Implications for data harmonization

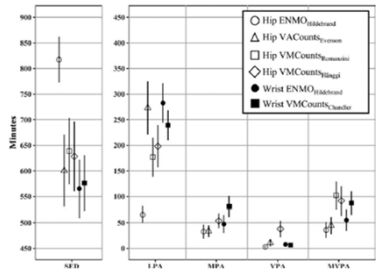
Jairo H. Migueles[1] | Cristina Cadenas-Sanchez[1] | Catrine Tudor-Locke[2] | Marie Löf[3,4] | Irene Esteban-Cornejo[1,5] | Pablo Molina-Garcia[1,6] | Jose Mora-Gonzalez[1] | Maria Rodriguez-Ayllon[1] | Eduardo Garcia-Marmol[1] | Ulf Ekelund[7] | Francisco B. Ortega[1,3]

TABLE 1 Children's age-appropriate cut-points for the estimation of sedentary time (SED) and physical activity (PA) intensities

References	Attachment site	Acceleration metric	Epoch length	SED/LPA	LPA/MPA	MPA/VPA
Hildebrand et al[7,27]	Hip	ENMO	5 s	63 mg	143 mg	465 mg
Hildebrand et al[7,27]	Wrist	ENMO	5 s	36 mg	201 mg	707 mg
Hänggi et al[28]	Hip	VMCounts	1 s	3 c	56 c	-
Romanzini et al[9]	Hip	VMCounts	15 s	180 c	757 c	1112 c
Chandler et al[8]	Wrist	VMCounts	5 s	305 c	818 c	1969 c
Evenson et al[26]	Hip	VACounts	15 s	25 c	574 c	1003 c

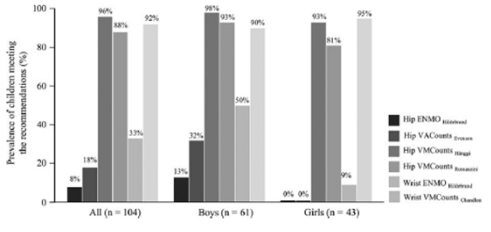
ENMO, Euclidean norm −1 *g*; VMCounts, Vector magnitude counts; c, Activity counts; VACounts, Vertical axis counts; LPA, Light physical activity; MPA, Moderate physical activity; VPA, Vigorous physical activity.

Mesmo dado, mas *cut-point* diferente



Migueles, et al. Scand J Med Sci Sports (2019)

Mesmo dado, mas *cut-point* diferente



Migueles, et al. Scand J Med Sci Sports (2019)

Modelo de aprendizado de máquina

Journal for the Measurement of Physical Behaviour, 2022, 5, 24-31
https://doi.org/10.1123/jmpb.2021-0015
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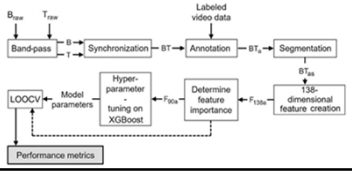
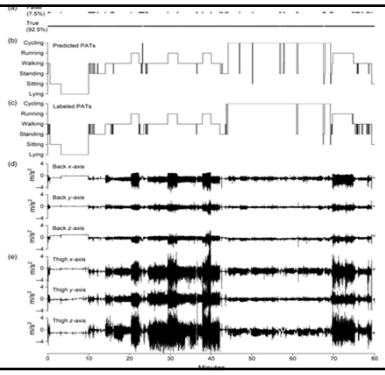
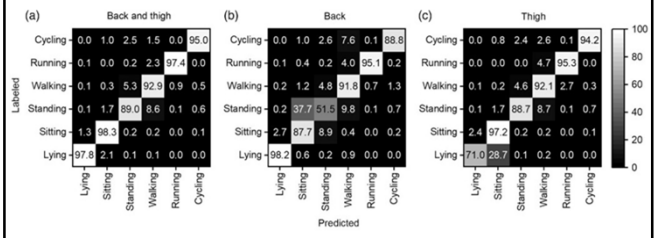
A Machine Learning Classifier for Detection of Physical Activity Types and Postures During Free-Living

Kerstin Bach,[1] Atle Kongsvold,[2] Hilde Bårdstu,[3,4] Ellen Marie Bardal,[2,3] Håkon S. Kjærnli,[1] Sverre Herland,[1] Aleksej Logacjov,[1] and Paul Jarle Mork[2]



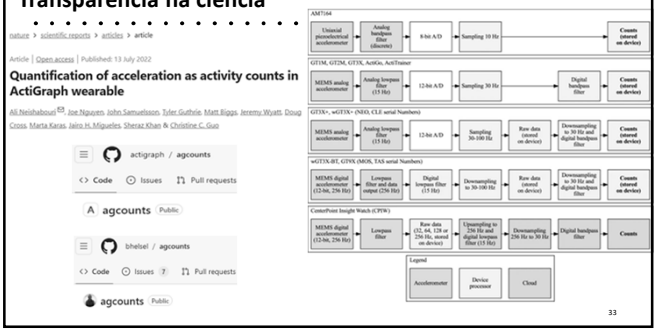


Bach, et al. JMPB (2022)

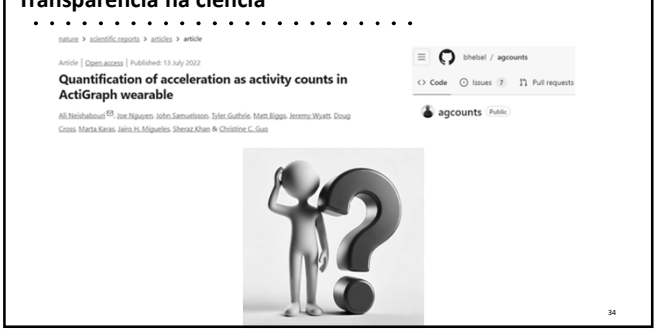


Bach, et al. JMPB (2022)

Transparência na ciência



Transparência na ciência



Transparência na ciência

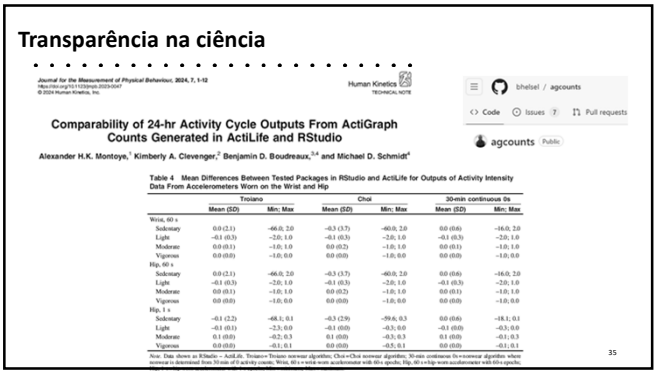


Table 4 Mean Differences Between Tested Packages in RStudio and ActiLife for Outputs of Activity Intensity Data From Accelerometers Worn on the Wrist and Hip

	Troiano		Choi		30-min continuous 0s	
	Mean (SD)	Min; Max	Mean (SD)	Min; Max	Mean (SD)	Min; Max
Wrist, 60 s						
Sedentary	0.0 (2.1)	-66.0; 2.0	-0.3 (3.7)	-60.0; 2.0	0.0 (0.6)	-16.0; 2.0
Light	-0.1 (0.3)	-2.0; 1.0	-0.1 (0.3)	-2.0; 1.0	-0.1 (0.3)	-2.0; 1.0
Moderate	0.0 (0.1)	-1.0; 1.0	0.0 (0.2)	-1.0; 1.0	0.0 (0.1)	-1.0; 1.0
Vigorous	0.0 (0.0)	-1.0; 0.0	0.0 (0.0)	-1.0; 0.0	0.0 (0.0)	-1.0; 0.0
Hip, 60 s						
Sedentary	0.0 (2.1)	-66.0; 2.0	-0.3 (3.7)	-60.0; 2.0	0.0 (0.6)	-16.0; 2.0
Light	-0.1 (0.3)	-2.0; 1.0	-0.1 (0.3)	-2.0; 1.0	-0.1 (0.3)	-2.0; 1.0
Moderate	0.0 (0.1)	-1.0; 1.0	0.0 (0.2)	-1.0; 1.0	0.0 (0.1)	-1.0; 1.0
Vigorous	0.0 (0.0)	-1.0; 0.0	0.0 (0.0)	-1.0; 0.0	0.0 (0.0)	-1.0; 0.0
Hip, 1 s						
Sedentary	-0.1 (2.2)	-68.1; 0.1	-0.3 (2.9)	-59.6; 0.3	0.0 (0.6)	-18.1; 0.1
Light	-0.1 (0.1)	-2.3; 0.0	-0.1 (0.0)	-0.3; 0.0	-0.1 (0.0)	-0.3; 0.0
Moderate	0.1 (0.0)	-0.2; 0.3	0.1 (0.0)	-0.3; 0.3	0.1 (0.0)	-0.1; 0.3
Vigorous	0.0 (0.0)	-0.1; 0.1	0.0 (0.0)	-0.5; 0.1	0.0 (0.0)	-0.1; 0.1

Note. Data shown as RStudio – ActiLife. Troiano = Troiano nonwear algorithm; Choi = Choi nonwear algorithm; 30-min continuous 0s = nonwear algorithm where nonwear is determined from 30 min of 0 activity counts; Wrist, 60 s = wrist-worn accelerometer with 60-s epochs; Hip, 60 s = hip-worn accelerometer with 60-s epochs;

Transparência na ciência

A frequência e a ordem do filtro influenciam o sinal?

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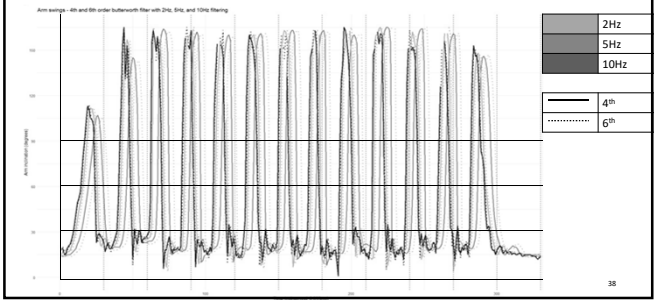
A frequência e a ordem do filtro influenciam o sinal?



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A autocalibração de acordo com a gravidade local é importante?

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Autocalibração de acordo com a gravidade local é importante?

J Appl Physiol 117: 738–744, 2014.
First published August 7, 2014; doi:10.1152/japplphysiol.00421.2014.

Autocalibration of accelerometer data for free-living physical activity assessment using local gravity and temperature: an evaluation on four continents

Vincent T. van Hees,[1,2] Zhou Fang,[2,3] Joss Langford,[3] Felix Assah,[4] Anwar Mohammad,[5] Inacio C. M. da Silva,[6,7] Michael I. Trenell,[1] Tom White,[7] Nicholas J. Wareham,[7] and Søren Brage[7]

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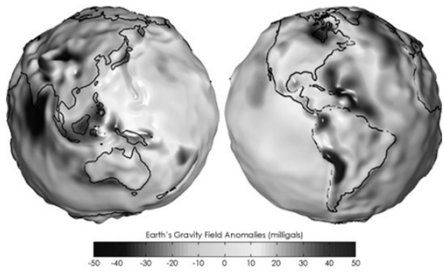
Autocalibração de acordo com a gravidade local é importante?



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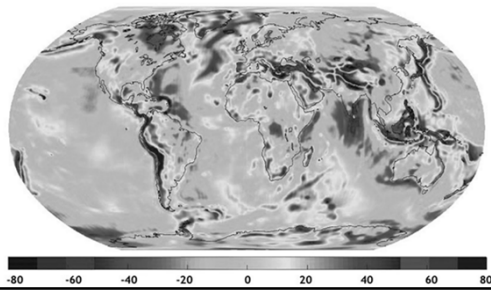
Autocalibração de acordo com a gravidade local é importante?



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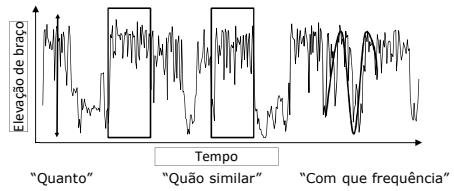
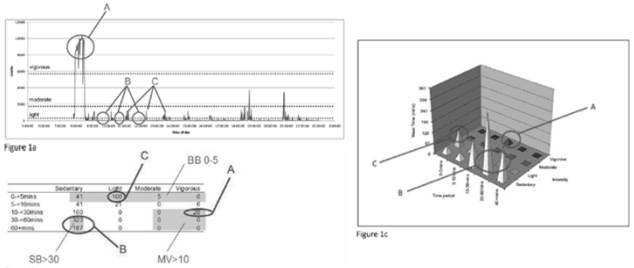
Padrão temporal



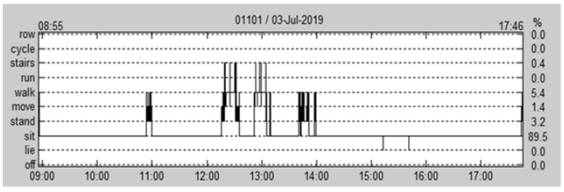
(Figura do Svend Erik Mathiassen)

Padrão temporal

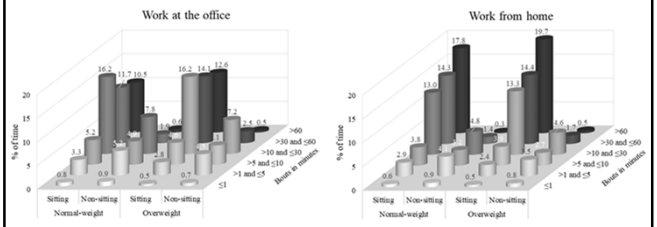


Straker, et al. JPAH (2014)

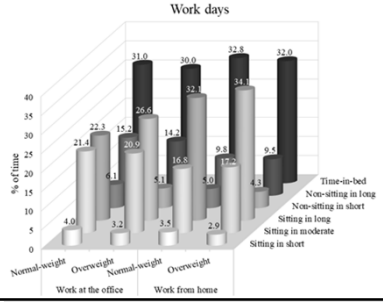
Padrão temporal



Padrão temporal



Padrão temporal



Diferentes *softwares*/algoritmos disponíveis

- Acti4 (*software*)
- ActiPASS (*software*)
- ActiMOTUS (*software*)
- ActivPAL (*software*)
- GGIR (R *package*)
- OM GUI (*software*)
- ProcessingPAL (*software* & R *package*)
- actimetric (R *package*)
- HUNT *algorithm* (R *package*)
- UK biobank *algorithm* (R *package*)
- nhanesaccel (R *package*)
- stepcount (R *package*)
- activAnalyzer (R *package*)
- popmetrics (R *package*)
- paat (Python *package*)
- agcounts (Python e R *package*)
- GENEAclassify (R *package*)
- SkotteChild (Acti4Child - MatLab codes)
- pampro (Python *package*)
- *De Maastricht studie - Acelerometry algorithm* (MatLab)
- DeepPostures (Python *algorithm*; *Convolutional Neural Network* (CNN) *Hip Accelerometer Posture* (CHAP))
- *Two-level behavioral classification* (TLBC)
- AccelerometerRepository

Desenvolvimento de algoritmos

Desenvolvimento de algoritmos

Os algoritmos devem ser basedos em uma população específica (por exemplo: crianças, adultos, idosos, pessoas saudáveis, etc)?

Obrigado