National University Heart Centre, Singapore

NUHS National University Health System

The Role of Technology in Exercise Promotion

7th Asian Preventive Cardiology and Cardiac Rehabilitation Conference

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10 Nov 2018

"Look, it even shows how much time I'm wasting on silly gadgets."

Disclosure

- I do not endorse any fitness brands
- I have used / am using the following:
  - Garmin Forerunner 210, 410
  - Fitbit Flex
  - Suunto Ambit
  - Runkeeper
  - Apple Health app

Scope

- The importance of physical activity and exercise
- Overview of wearable technology
- Review of evidence:
  - Reliability + Validity
  - Clinical trial data on effectiveness

Rank	Cause of Death	Percent of Deaths
1	High Blood Pressure	12.8%
2	Tobacco Use	8.7%
3	High Blood Glucose	5.8%
4	**Physical Inactivity**	**5.5%**
5	Overweight & Obesity	4.8%
6	High Cholesterol	4.5%
7	Unsafe Sex	4.0%
8	Alcohol Use	3.8%
9	Childhood Underweight	3.8%
10	Indoor Smoke Solid Fuels	3.3%

Source: WHO

World Health Organization

WHAT IS THE EVIDENCE FOR EXERCISE IN THE GENERAL POPULATION?

"Sometimes it's good to change your walking routine. Try walking around the block instead of wandering around the kitchen."

World Health Organization

Prevention of Cardiovascular Disease

Guidelines for assessment and management of cardiovascular risk

Aerobic Activity Intensity Classifications

Intensity	Talk test	%Heart rate*	0 – 10 Scale**
Light	Minimal increase in breathing rate – one is able to carry on a conversation	50 – 63%	3 – 4
Moderate	Noticeable increase in breathing rate – one is able to carry on a conversation but does not have enough breath to sing	64 – 76%	5 – 6
Vigorous	Large increase in breathing rate – one is not able to carry on a conversation but is not out of breath	77 – 89%	7 – 8

PHYSICAL ACTIVITY

All individuals should be strongly encouraged to take at least 30 minutes of moderate physical activity (e.g. brisk walking) a day, through leisure time, daily tasks and work-related physical activity. (1+, A)

European Heart Journal
doi:10.1093/eurheartj/ehw106

2016 European Guidelines on cardiovascular disease prevention in clinical practice

Recommendations	Class[a]	Level[b]
It is recommended for healthy adults of all ages to perform at least 150 minutes a week of moderate intensity or 75 minutes a week of vigorous intensity aerobic PA or an equivalent combination thereof.	I	A
For additional benefits in healthy adults, a gradual increase in aerobic PA to 300 minutes a week of moderate intensity, or 150 minutes a week of vigorous intensity aerobic PA, or an equivalent combination thereof is recommended.	I	A
Regular assessment and counselling on PA is recommended to promote the engagement and, if necessary, to support an increase in PA volume over time.[d]	I	B
PA is recommended in low-risk individuals without further assessment.	I	C
Multiple sessions of PA should be considered, each lasting ≥10 minutes and evenly spread throughout the week, i.e. on 4–5 days a week and preferably every day of the week.	IIa	B
Clinical evaluation, including exercise testing, should be considered for sedentary people with CV risk factors who intend to engage in vigorous PAs or sports.	IIa	C

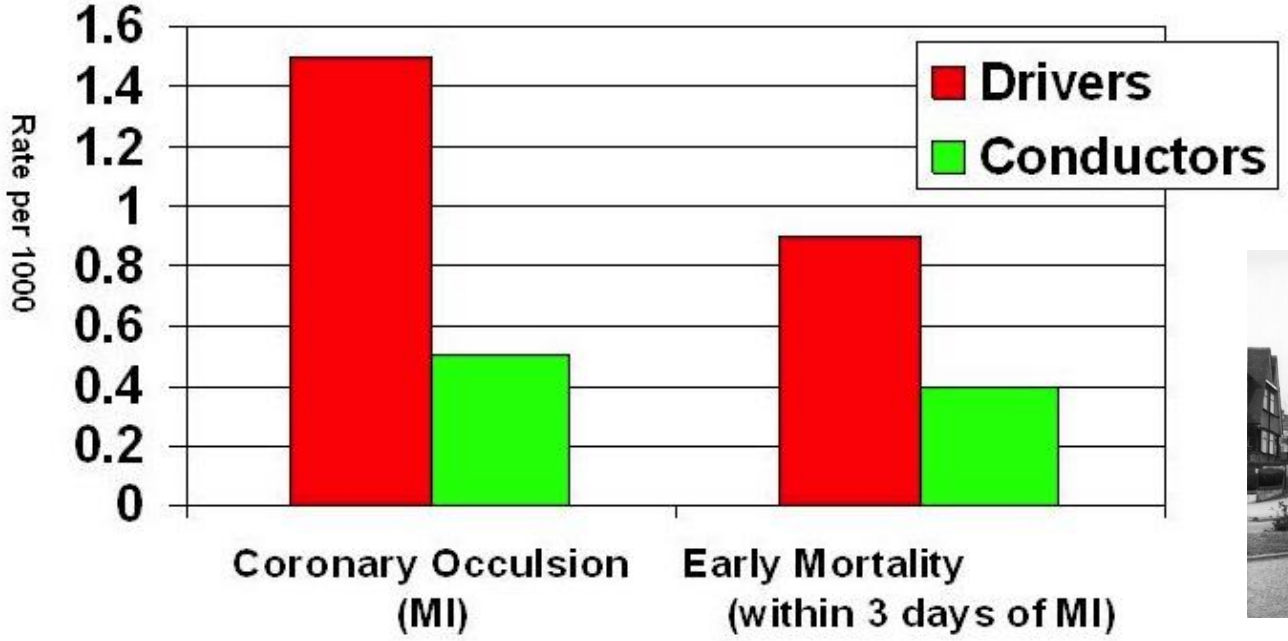
The World is not active enough!

Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants

Lancet Glob Health 2018; 6: e1077–86

- Global age-standardised prevalence of insufficient physical activity: 27·5%
- Highest levels: women in Latin America and the Caribbean (43·7%), south Asia (43·0%), and high-income Western countries (42·3%)
- High-income countries (36·8%) more inactive than low-income countries (16·2%)
- Policies to increase population levels of physical activity need to be prioritised and scaled up ***urgently***.

Coronary Artery Disease of 31,000 London Transport Workers



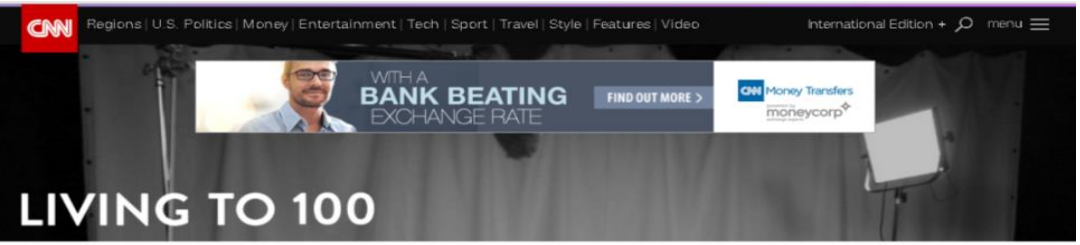
Morris JN et al., *Lancet* 1953

Annals of Internal Medicine REVIEW

Sedentary Time and Its Association With Risk for Disease Incidence, Mortality, and Hospitalization in Adults

A Systematic Review and Meta-analysis

Aviroop Biswas, BSc; Paul I. Oh, MD, MSc; Guy E. Faulkner, PhD; Ravi R. Bajaj, MD; Michael A. Silver, BSc; Marc S. Mitchell, MSc; and David A. Alter, MD, PhD



Sitting will kill you, even if you exercise

By Jen Christensen, CNN

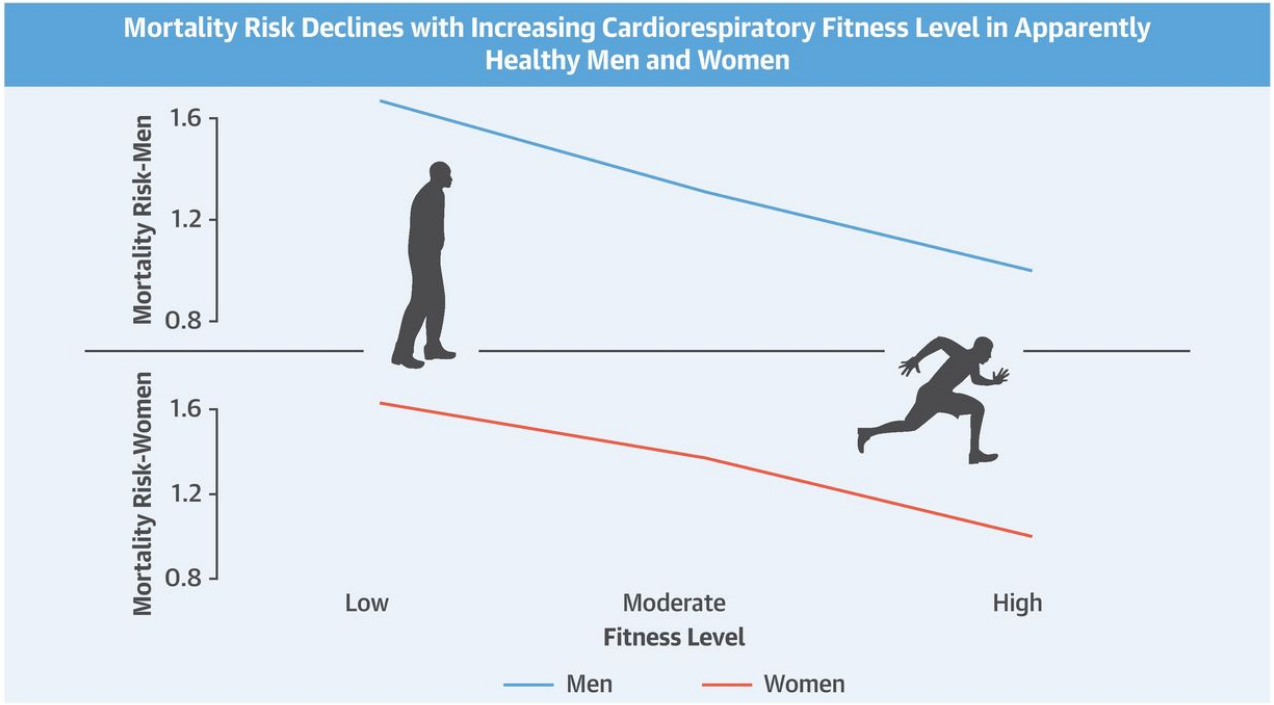
Updated 1240 GMT (2040 HKT) April 30, 2015

N > 800,000

Sedentary behaviour eg. sitting, television watching, and reclined posture *INCREASED*:

- **all-cause mortality** **(HR, 1.24 [95% CI,1.090 to 1.410])**
- **cardiovascular disease incidence** **(HR, 1.14 [CI, 1.002 to 1.729])**
- **cancer incidence** **(HR, 1.13 [CI, 1.053 to 1.213])**
- **type 2 diabetes incidence** **(HR, 1.91 [CI, 1.642 to 2.222])**

CENTRAL ILLUSTRATION: Directly Measured Cardiorespiratory Fitness for Mortality Risk Prediction



Imboden, M.T. et al. J Am Coll Cardiol. 2018;72(19):2283-92.

- n>4,000
- Apparently healthy
- CPET for all
- 24+ yrs follow up
- 1 MET increase in fitness a/w:
- 11.6% less all cause mortality
- 16.1% less CVD mortality
- 14.0% less cancer mortality

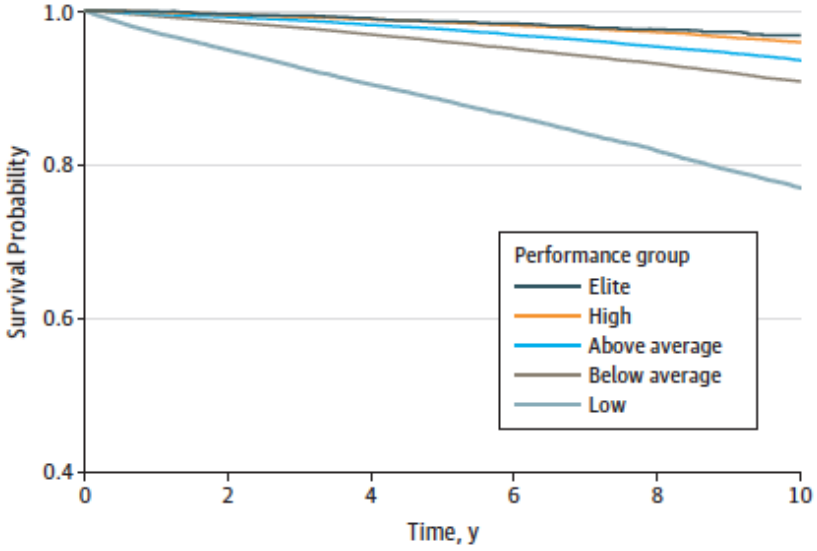
JAMA Network Open

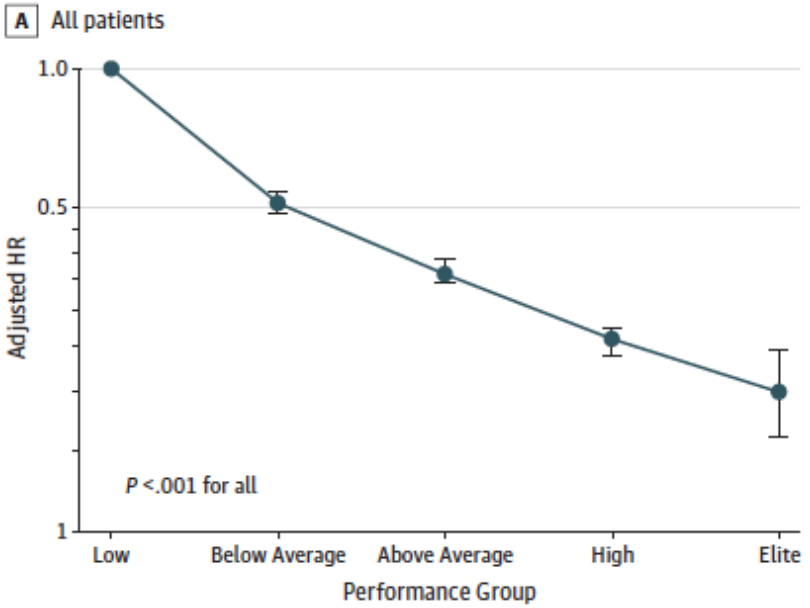
JAMA Network Open. 2018;1(6):e183605.

N > 122,000

Original Investigation | Cardiology

Association of Cardiorespiratory Fitness With Long-term Mortality Among Adults Undergoing Exercise Treadmill Testing





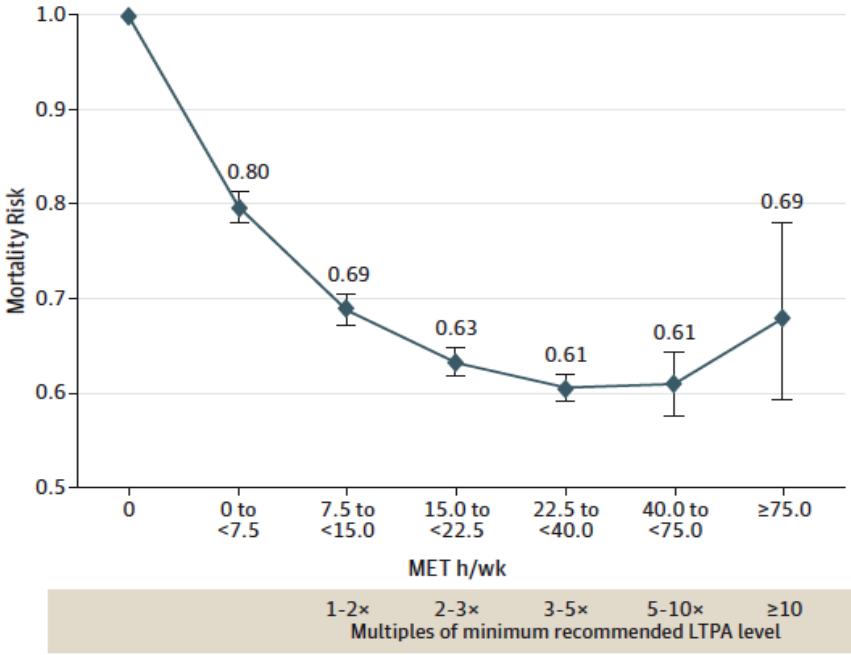
Research

Original Investigation

Leisure Time Physical Activity and Mortality
A Detailed Pooled Analysis of the Dose-Response Relationship

Hannah Arem, MHS, PhD; Steven C. Moore, PhD; Alpa Patel, PhD; Patricia Hartge, ScD; Amy Berrington de Gonzalez, DPhil; Kala Visvanathan, MBBS, MPH; Peter T. Campbell, PhD; Michal Freedman, JD, PhD; Elisabete Weiderpass, MD, MSc, PhD; Hans Olov Adami, MD, PhD; Martha S. Linet, MD; I.-Min Lee, MBBS, ScD; Charles E. Matthews, PhD

JAMA Intern Med. 2015;175(6):959-967. doi:10.1001/jamainternmed.2015.0533
Published online April 6, 2015.



N = 661,137 (median age 62 years; range, 21-98 years)
Follow-up 14.2 years

20% lower mortality risk among those performing less than the recommended 7.5 MET hrs/wk
(HR 0.80 [95%CI, 0.78-0.82])

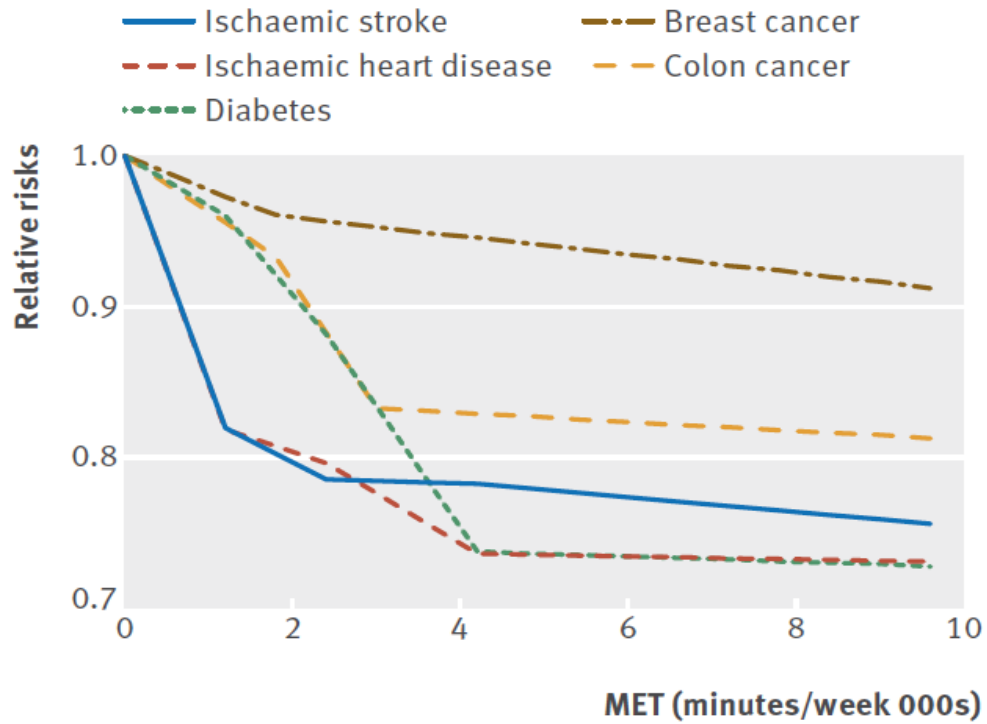
31% lower risk at 1 to 2 times above the recommended minimum
(HR 0.69 [95%CI, 0.67-0.70])

37% lower risk at 2 to 3 times above the recommended minimum
(HR 0.63 [95%CI 0.62-0.65]).

No evidence of harm at 10 or more times the recommended minimum
(HR, 0.69 [95%CI, 0.59-0.78])

Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013

Hmwe H Kyu,[1] Victoria F Bachman,[2] Lily T Alexander,[1] John Everett Mumford,[1] Ashkan Afshin,[1] Kara Estep,[1] J Lennert Veerman,[3] Kristen Delwiche,[4] Marissa L Iannarone,[1] Madeline L Moyer,[1] Kelly Cercy,[1] Theo Vos,[1] Christopher J L Murray,[1] Mohammad H Forouzanfar[1]



174 studies totaling almost 150 million person years of follow up

Highly active (≥8000 MET minutes/week) vs. insufficiently active (<600 MET minutes/week)

Risk reductions:

- **14% for breast cancer**
- **21% for colon cancer**
- **28% for diabetes**
- **25% for ischemic heart disease**
- **26% for ischemic stroke**

Slide credit: Prof Sanjay Sharma

↓ Obesity
↓ BP
↓Diabetes
↓risk of CAD
↓risk of AF

↑ Coronary reserve in CAD
↑ Functional capacity and prognosis in HF

Exercise IS beneficial

Events

Recommended level of exercise 150 mins/week

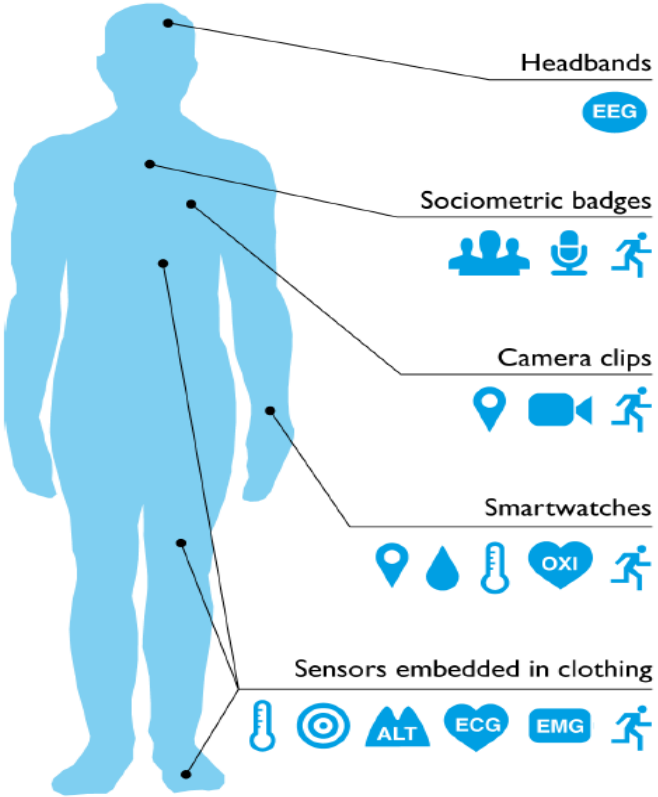
13-20% ↓ in cardiac mortality per MET increase

Sedentary | 5 METS | 6-8 METS | 10-12 METS | >14 METS

HOW DO WE PROMOTE EXERCISE?

WEARABLE TECHNOLOGY

Smart electronic devices (electronic device with microcontrollers) that can be worn on the body as implant or accessories



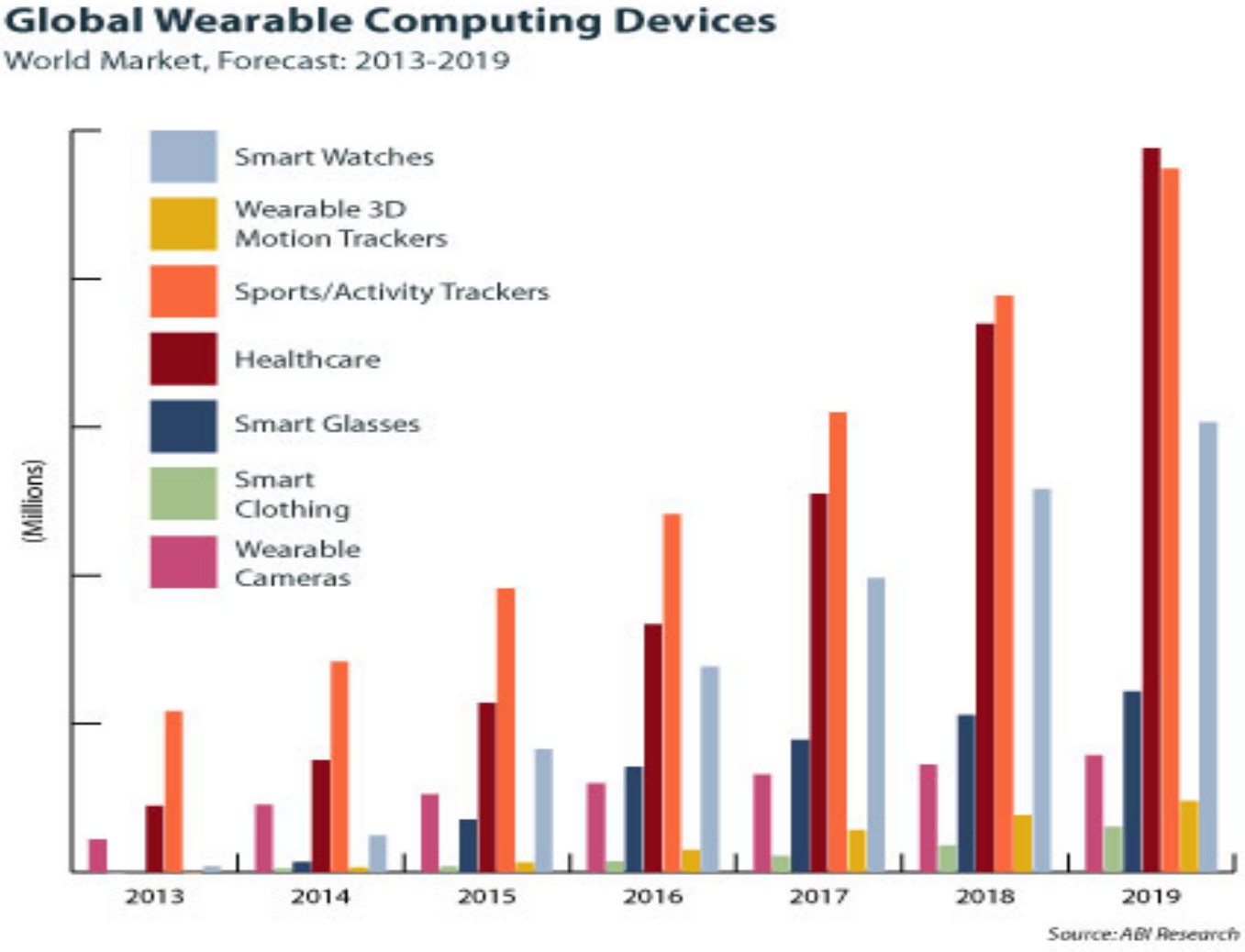
- Accelerometer
- Altimeter (ALT)
- Digital camera
- Electrocardiogram (ECG)
- Electromyograph (EMG)
- Electroencephalogram (EEG)
- Electrodermograph
- Location GPS
- Microphone
- Oximeter (OXI)
- Bluetooth proximity
- Pressure
- Thermometer

Citation: Piwek L, Ellis DA, Andrews S, Joinson A (2016) The Rise of Consumer Health Wearables: Promises and Barriers. PLoS Med 13(2): e1001953. doi:10.1371/journal.pmed.1001953

THE RISE AND RISE OF WEARABLE TECHNOLOGY

CREDIT SUISSE

Source: Company Website, iFlowreader, Credit Suisse Estimates,



PROJECTED GROWTH OF WEARABLES

WEARABLES-RELATED RESEARCH

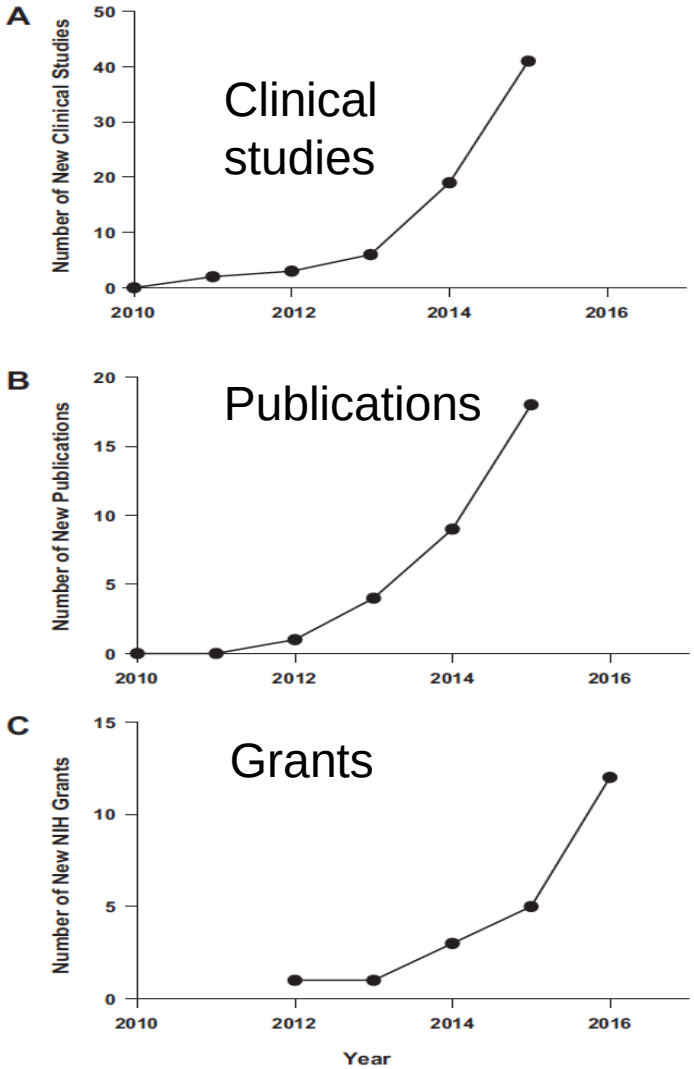


Table 2. *Characteristics of clinical trials in clinicaltrials.gov citing use of Fitbit physical activity monitors*

Study Type	Number of Clinical Trials
Observational	11
Interventional	116
Total	127
Participant age	
Children only (<14 yr old)	4
Children to young adult (<24 yr old)	10
Adults only (>18 yr old)	107
All ages	6
Estimated enrollment	
1–99	88
100–999	34

Am J Physiol Regul Integr Comp Physiol 312: R358–R367, 2017.
First published January 4, 2017; doi:10.1152/ajpregu.00349.2016.

ARE WEARABLES RELIABLE?

"I've been feeling healthier since I attached my fitbit to the collar of the neighbor's terrier."

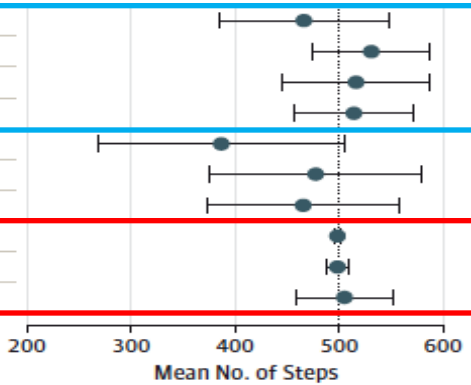
Accuracy of Smartphone Applications and Wearable Devices for Tracking Physical Activity Data

Counting steps

- 14 healthy participants (mean age 28.1 yrs) walked on a treadmill at 3 mph for 500 and 1500 steps (2 sets each)

Figure 1. Device Outcomes for the 500 Step Trials

Device	No. of Observations
Galaxy S4 Moves App	27
iPhone 5s Moves App	28
iPhone 5s Health Mate App	28
iPhone 5s Fitbit App	28
Nike Fuelband	28
Jawbone UP24	28
Fitbit Flex	28
Fitbit One	27
Fitbit Zip	27
Digi-Walker SW-200	28



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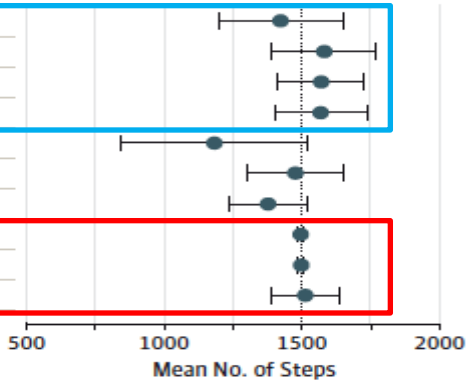
Digi-Walker SW-200	28



Heart rate monitors

Getty Images

EXERCISE/FITNESS

The Apple Watch Is the Most Accurate Wrist Wearable

Mandy Oaklander
Updated: Oct 12, 2016 1:41 PM ET

TIME Health *For more, visit TIME Health.*

Table. Concordance Correlation Coefficients for Each Heart Rate Monitor

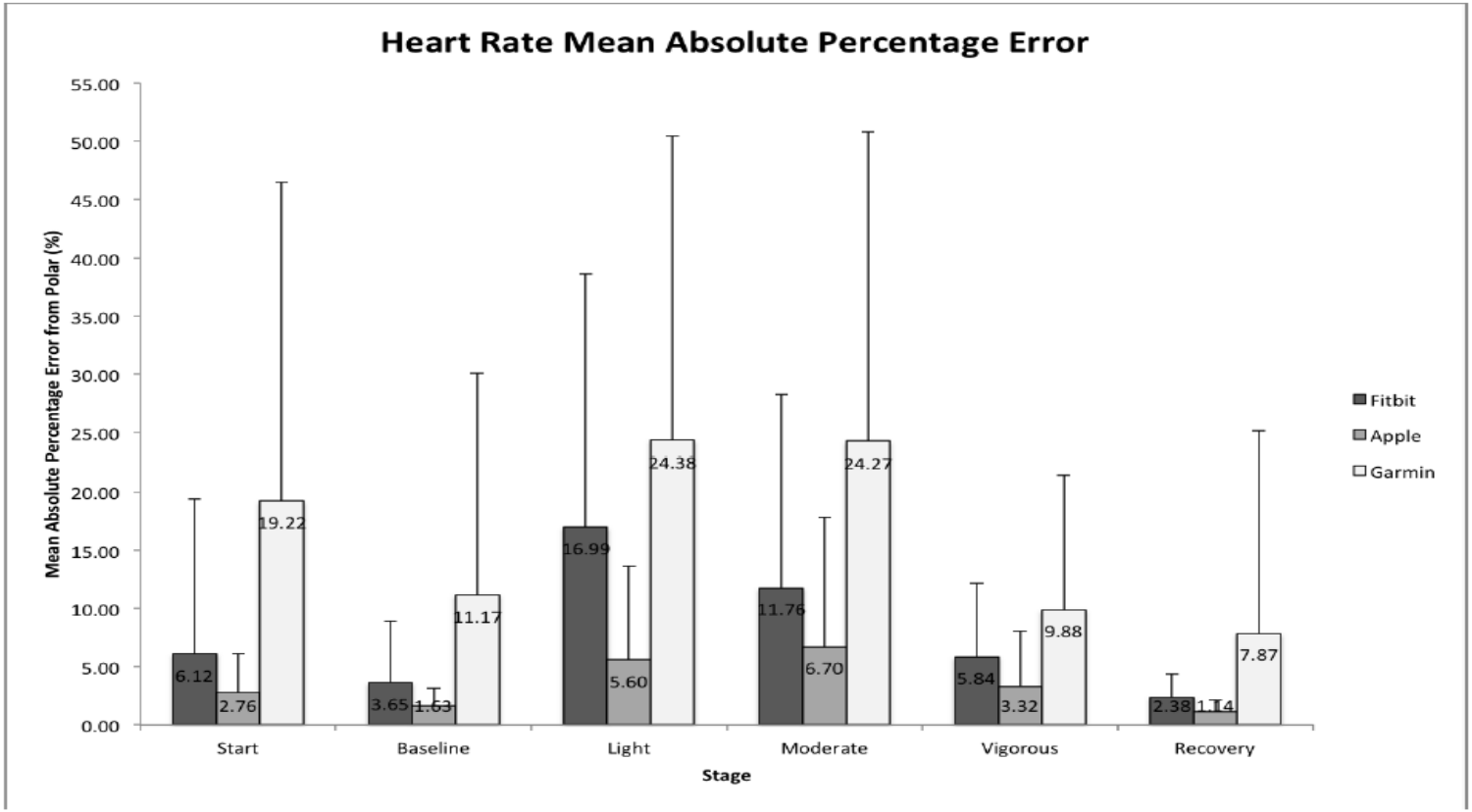
Device	Agreement With Electrocardiogram Concordance Correlation Coefficients (95% CI)
Polar H7	.99 (.987-.991)
Apple Watch	.91 (.884-.929)
Mio Fuse	.91 (.882-.929)
Fitbit Charge HR	.84 (.791-.872)
Basis Peak	.83 (.779-.865)

JAMA Cardiology Published online October 12, 2016

Estimating Accuracy at Exercise Intensities: A Comparative Study of Self-Monitoring Heart Rate and Physical Activity Wearable Devices

(JMIR Mhealth Uhealth 2017;5(3):e34)

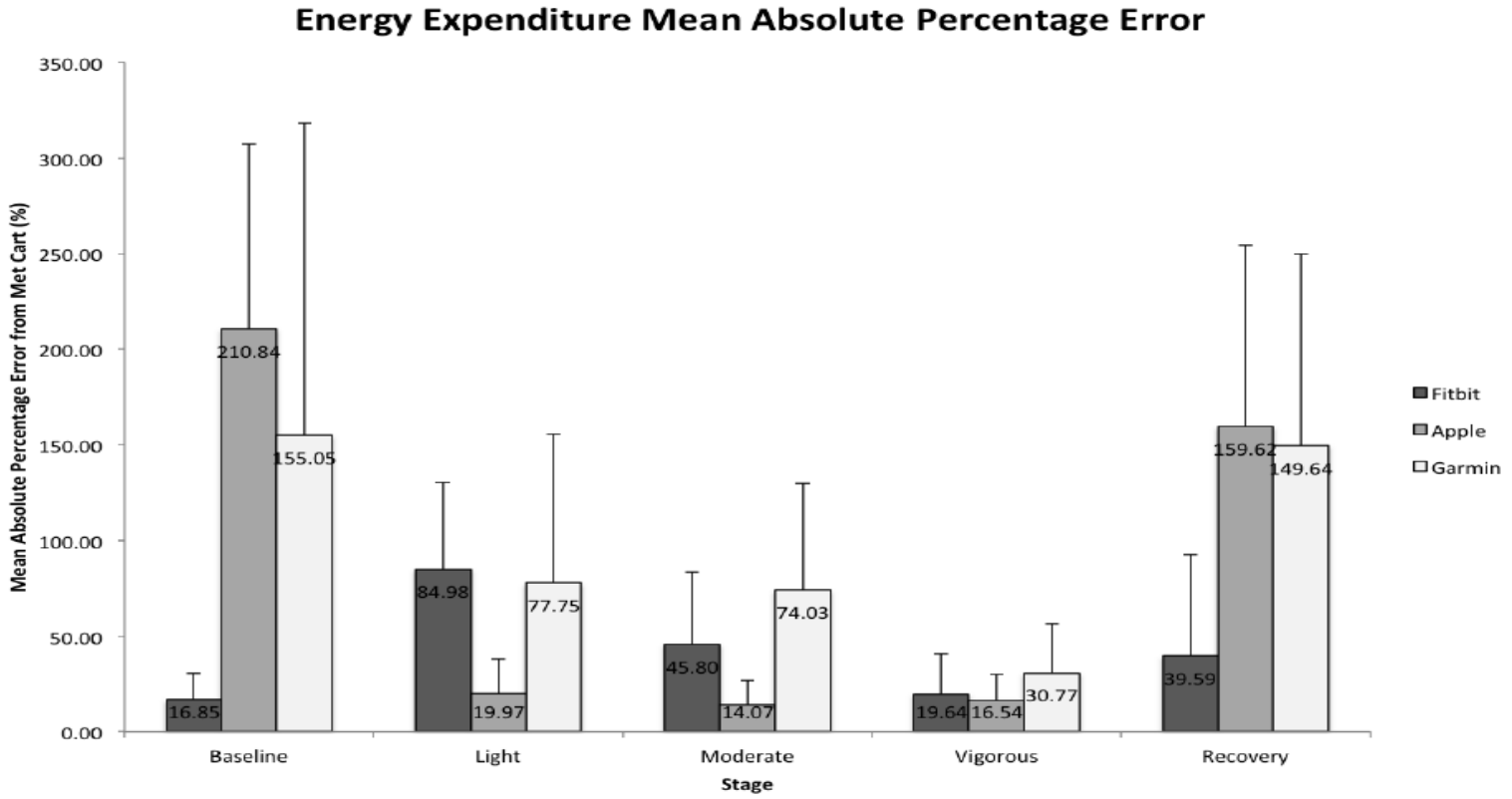
Figure 1. Mean absolute percentage error (MAPE; %) of the devices for heart rate from the Polar heart rate monitor criterion. MAPE values are presented by exercise intensity per device. Error bars represent one standard deviation from the mean score.



Estimating Accuracy at Exercise Intensities: A Comparative Study of Self-Monitoring Heart Rate and Physical Activity Wearable Devices

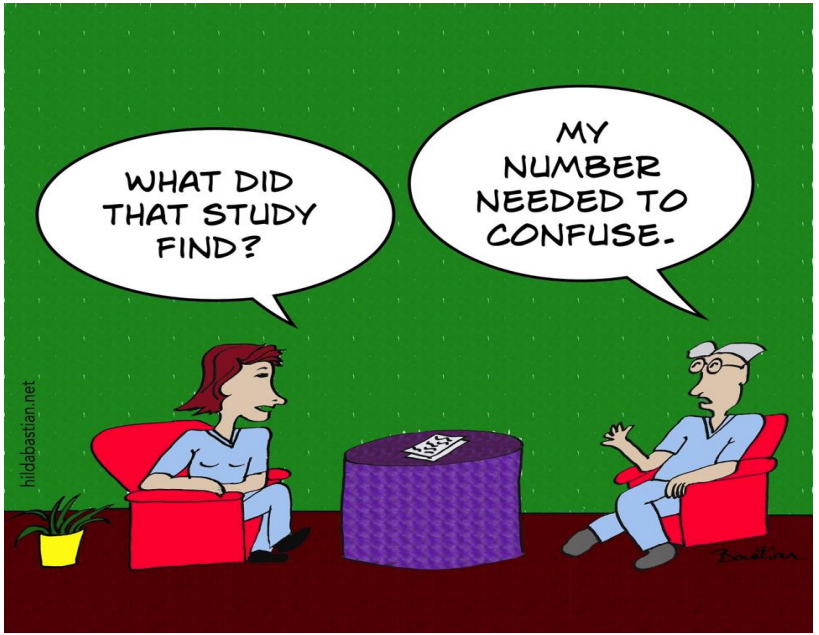
(JMIR Mhealth Uhealth 2017;5(3):e34)

Figure 2. Mean absolute percentage error (MAPE; %) of the devices for energy expenditure from the TrueOne 2400 metabolic cart criterion. MAPE values are presented by exercise intensity per device. Error bars represent one standard deviation from the mean score.



	Energy Expenditure			Heart Rate			Step Count		
	ICC	MAPE	Agreement	ICC	MAPE	Agreement	ICC	MAPE	Agreement
Apple Watch	0.493	27%	-232 to -14	0.95	-	-13.5 to 14.6	0.727	1.08%	-69.8 to 92.0
fitbit									
Charge HR	0.693	36%	-137 to 17.3	0.805	-	-34 to 23	0.526	3.03%	-108 to 70.5
Flex	-	34%	-	-	-	-	0.80	14.56%	-41.1 to 101.8
Zip	-	39.8%	-	-	-	-	1.0	22.18%	-8.7 to 10.1
One	-	25.4%	-	-	-	-	-	25%	-
Blaze	-		-	0.67	-	-30 to 45	-	-	-
GARMIN									
Vivofit	-	44.6%	-93.8 to 271.8	-	-	-	0.75	5.5%	-65.1 to 103.7
Vivosmart	-	-	-	-	-	-	0.592	3.9%	-89.3 to 183.3
Forerunner 235	-	-	-	0.81	-	-27 to 33	-	-	-
SAMSUNG									
Samsung Gear S	0.86	-	-73.5 to 21.3	0.80	-	-27.3 to 13.1	0.605	3.3%	-204.7 to 223.3

Bunn et al. Int J Exerc Sci 11(7): 503-515, 2018



WEARABLES IN PRIMARY PREVENTION: CLINICAL TRIALS

Using Pedometers to Increase Physical Activity and Improve Health

A Systematic Review

JAMA. 2007;298(19):2296-2304

- 26 studies (8 RCT, 18 observational)
- n = 2767
- Mean age 49 yrs; 85% female
- Mean duration 18 wks
- Most participants overweight, normotensive & relatively inactive at baseline (7473±1385 steps/day)

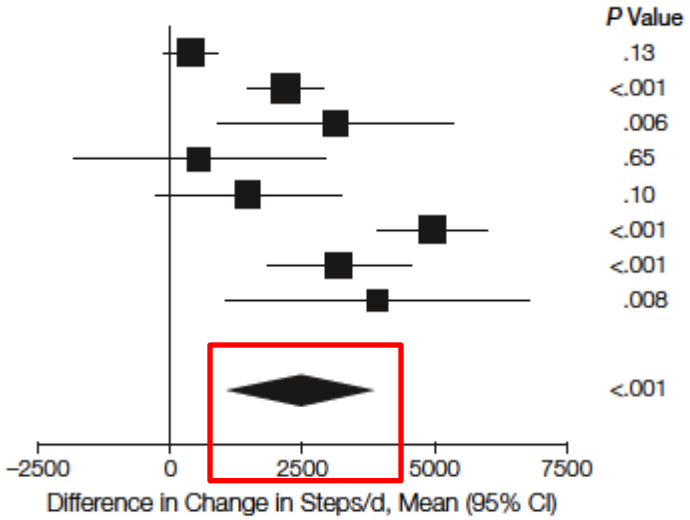


Table 2. Baseline Participant Characteristics[a]

Characteristic	No. of Studies Reporting This Characteristic (No. of Participants)	Preintervention, Mean (SD)	Change Postintervention: Mean Change (95% Confidence Interval)[b]	Change Postintervention: P Value
BMI	18 (562)	30 (3.4)	−0.38 (−0.05 to −0.72)	.03
Blood pressure, mm Hg				
Systolic	12 (468)	129 (7.5)	−3.8 (−1.7 to −5.9)	<.001
Diastolic	12 (468)	79 (4.5)	−0.3 (0.02 to −0.46)	.001
Cholesterol, mmol/L				
Total	7 (192)	5.14 (0.3)	−0.09 (−0.32 to 0.15)	.50
HDL	7 (192)	1.34 (0.20)	0.06 (−0.012 to 0.14)	.10
LDL	7 (192)	2.93 (0.01)	−0.06 (−0.25 to 0.13)	.50
Triglycerides, mmol/L	7 (192)	2.19 (0.85)	−0.26 (−0.56 to 0.04)	.09
Fasting glucose, mmol/L	7 (211)	7.09 (2.09)	−0.03 (−0.11 to 0.11)	.70

Effectiveness of a smartphone application to promote physical activity in primary care:

the SMART MOVE randomised controlled trial

British Journal of General Practice, July 2014

- Aim: to evaluate effectiveness of a smartphone app to promote physical activity in primary care
- N = 77; mean age 44; 64% female; mean BMI 28.2
- Android users
- 8-wk open label RCT in rural primary care in Ireland
- Primary outcome: difference in mean daily step count
- Secondary outcomes: BP, HR, BMI, QoL
- All participants given physical activity goals + info on exercise benefits
- Randomised to smartphone app (Accupedo-Pro Pedometer) vs control

Primary outcome	Week 1, *n* mean (SD)	Week 8, *n* mean (SD)	Mean difference (SD)	*P*-value
Step count				
Control group	41 5138 (3873)	35 4859 (3474)	–386 (3281)	0.025[a]
Intervention group	37 4365 (2732)	31 5855 (4264)	1631 (3842)	

- No significant differences between both groups in secondary outcomes

Sports Med
DOI 10.1007/s40279-014-0142-5 Published online: 05 February 2014

SYSTEMATIC REVIEW

Measuring and Influencing Physical Activity with Smartphone Technology: A Systematic Review

- Databases from 2007 to 2013 searched
- 5 of 26 eligible studies assessed physical activity intervention
- Outcome measure = step counts (all 5 studies)
- 4 of 5 studies (three pre–post, one comparative) reported increases in physical activity
  (12–42 participants, 800–1,104 steps/day, 2 weeks–6 months)
- One case-control study reported maintenance of physical activity over 3 months
  (n = 200 participants;10,000 steps/day)

- Intervention effects modest at best
- RCT designs, larger sample sizes and longer study periods needed

RESEARCH ARTICLE

A Primary Care Nurse-Delivered Walking Intervention in Older Adults: PACE (Pedometer Accelerometer Consultation Evaluation)-Lift Cluster Randomised Controlled Trial

Citation: Harris T, Kerry SM, Victor CR, Ekelund U, Woodcock A, Iliffe S, et al. (2015) A Primary Care Nurse-Delivered Walking Intervention in Older Adults: PACE (Pedometer Accelerometer Consultation Evaluation)-Lift Cluster Randomised Controlled Trial. PLoS Med 12(2): e1001783. doi:10.1371/journal.pmed.1001783

- **N = 298, older adults (age 60 – 74 yrs) referred from family practice**
- **Control group: usual care**
- **Intervention group: Pedometer + Accelerometer + Nurse consultation + Diary**
- **3-month intervention with follow-up at 12 months**

Outcome Measure	Control Group (Mean [SD])			Intervention Group (Mean [SD])			Treatment Effect at 3 Months[a]			Treatment Effect at 12 Months[a]		
	Baseline	3 Months	12 Months	Baseline	3 Months	12 Months	Effect	95% CI	*p*-Value	Effect	95% CI	*p*-Value
n	148	138	136	150	142	137	280			273		
Daily step count	7,380 (2,988)	6,904 (3,061)	6,872 (2,792)	7,314 (2,693)	7,903 (3,194)	7,514 (3,165)	1,037	(513–1,560)	<0.001	609	(104–1,115)	0.018
MVPA: Total weekly minutes	301 (169)	278 (169)	285 (174)	296 (154)	333 (185)	319 (188)	66	(36–96)	<0.001	40	(10–70)	0.009
MVPA: Total weekly minutes in ≥10 minute bouts	88 (113)	72 (102)	75 (108)	96 (104)	134 (138)	118 (130)	63	(40–87)	<0.001	40	(17–63)	0.001
Daily counts	246,610 (111,809)	231,278 (110,870)	239,158 (114,776)	244,225 (94,980)	266,357 (119,648)	257,511 (117,882)	40,459	(21,483–59,436)	<0.001	21,436	(2,207–40,665)	0.029
Counts per minute of wear-time	310 (129)	295 (127)	304 (136)	306 (112)	333 (140)	322 (139)	48	(25–70)	<0.001	23	(–0.7 to 46)	0.057

- **No effect in other outcomes (eg. BMI, fat mass, Depression/Anxiety scores)**

JAMA | Original Investigation

Effect of Wearable Technology Combined With a Lifestyle Intervention on Long-term Weight Loss

The IDEA Randomized Clinical Trial

JAMA. 2016;316(11):1161-1171. doi:10.1001/jama.2016.12858
Corrected on September 22, 2016.

John M. Jakicic, PhD; Kelliann K. Davis, PhD; Renee J. Rogers, PhD; Wendy C. King, PhD; Marsha D. Marcus, PhD; Diane Helsel, PhD, RD; Amy D. Rickman, PhD, RD, LDN; Abdus S. Wahed, PhD; Steven H. Belle, PhD

- N = 470, age 18 – 35, Overweight to obese (BMI 25 to 40)
- Does adding wearable technology to behavioural intervention improve long term (24 months) weight loss?
- → Standard (n = 233; 170 completed study)
  (behavioural intervention including phone counseling, text messages)
  → Enhanced (n = 237; 181 completed study)
  (addition of BodyMedia Fit system)
- Primary outcome: Weight change at 24 months
- Data were considered valid if the participant wore device ≥10 hrs/day for ≥4 days during observation period

Results

	Standard Intervention	Enhanced Intervention
Weight, mean (95% CI), kg		
Baseline	95.2 (93.0-97.3)	96.3 (94.2-98.5)
24 mo	89.3 (87.1-91.5)	92.8 (90.6-95.0)
Estimated weight loss, mean (95% CI), kg	5.9 (5.0-6.8)	3.5 (2.6-4.5)

- **74.5% completed study**
- **LESS weight loss in group with wearable technology**
- **Both groups had significant improvements in:**
  →body composition
  →fitness
  →physical activity
  →diet, but with no significant difference between groups
- **Conclusion: Wearable technology does not offer any advantage over traditional intervention**

Criticisms

- **Poor usage: median use 170 of 540 days; median wear time 4 hrs/day**
- **Device used in trial discontinued in 2014 & substantially different from current wearables; unsatisfactory user experience**
- **Timing of introduction of device: at month 7 into trial (existing habits of manual tracking of activity may have been interrupted)**

Effectiveness of activity trackers with and without incentives to increase physical activity (TRIPPA): a randomised controlled trial

Eric A Finkelstein, Benjamin A Haaland, Marcel Bilger, Aarti Sahasranaman, Robert A Sloan, Ei Ei Khaing Nang, Kelly R Evenson

www.thelancet.com/diabetes-endocrinology **Published online October 4, 2016** **http://dx.doi.org/10.1016/S2213-8587(16)30284-4**

- **6-month RCT + 6-month follow up**
- **Study participants: Aged 21 – 65, desk-bound office workers**
- **4 arms (1:1:1:1 ratio) n = 800**
  - **→ Control (no tracker, no incentives)**
  - **→ Activity tracker (Fitbit Zip)**
  - **→ Activity tracker + charitable incentives**
  - **→ Activity tracker + cash incentives**

Incentives:
$15 for 50,000 – 70,000 steps/wk
$30 for >70,000 steps/wk
Baseline $4/wk participation fee for all
Primary outcome: weekly mod to vigorous physical activity (MVPA) bout min at 6 & 12 months

Results

- At 6 months, vs. control
  → Fitbit: not significant (16 min/wk) [–2 to 35; p=0.0854]

  → charity: +21 min/wk (2–39; p=0.0310)

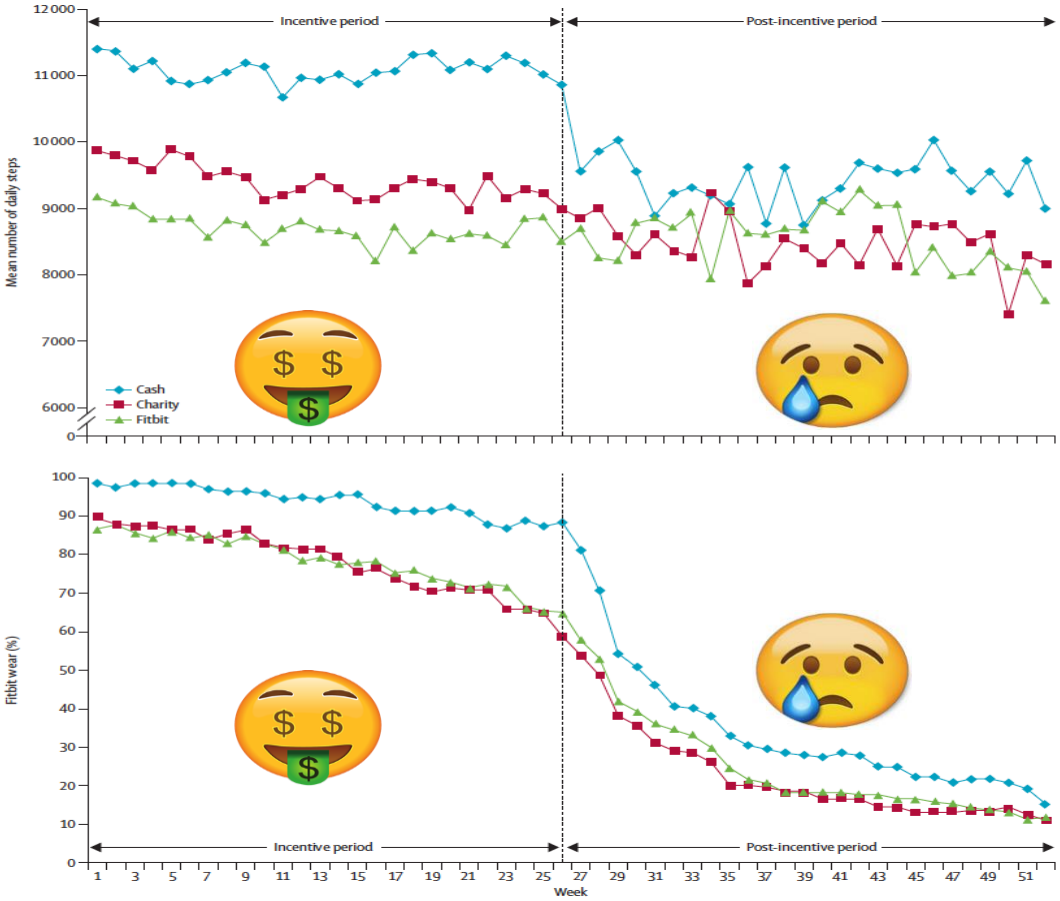
  → cash: +29 min/wk (95% CI 10–47; p=0.0024)

- At 12 months, vs. control
  → Fitbit: +37 min/wk (19–56; p=0.0001)

  → charity: +32 min/wk (12–51; p=0.0013)

  → cash: not significant (15 min/wk) [–5 to 34; p=0.1363])

- No improvement in health outcomes (weight, BP, VO_2, QoL)

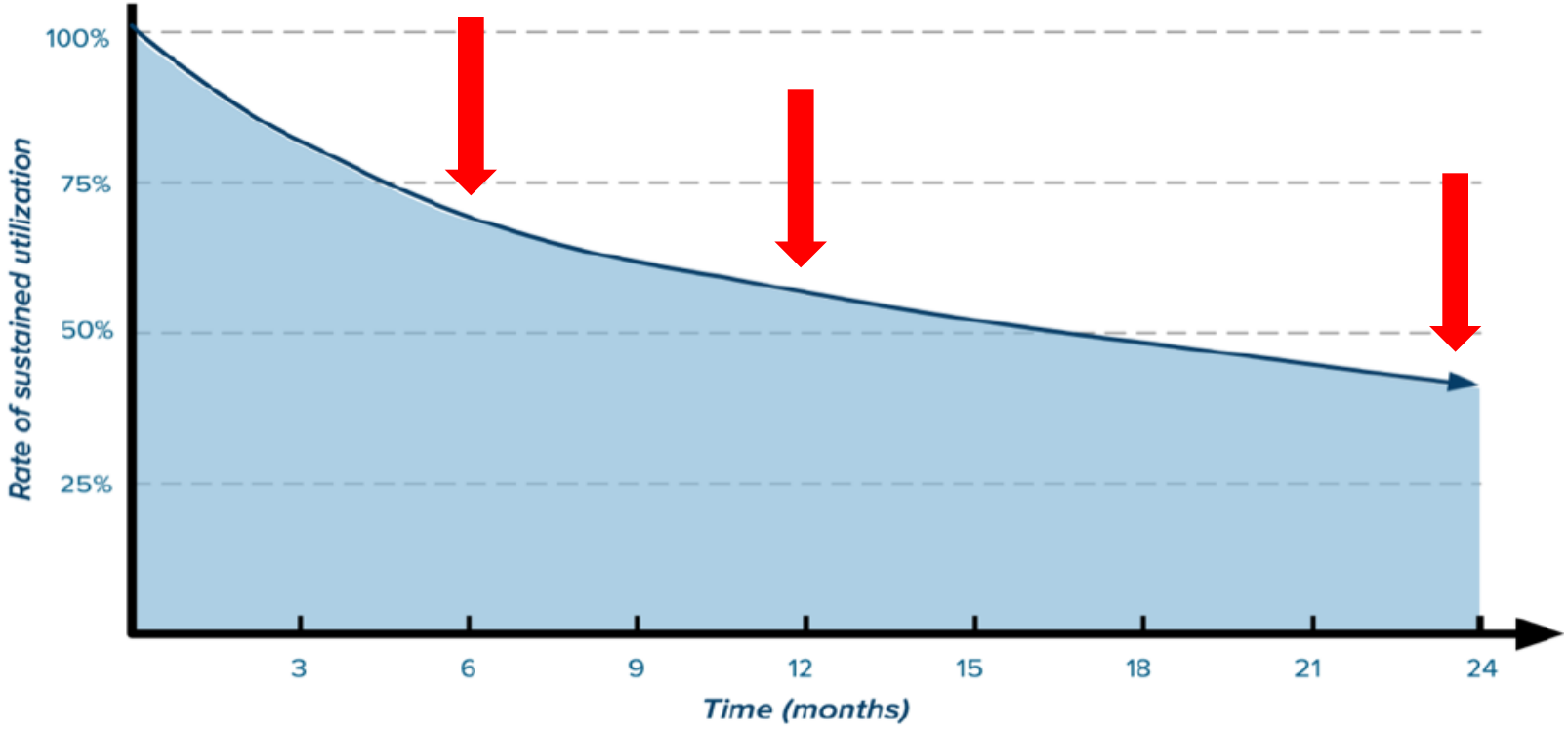


- Activity trackers seem to have some effect on physical activity vs. control group at 12 months, but does not translate to improved health outcomes

THE BOTTOMLINE

"Here—go make Daddy's Fitbit think he's exercising."

LONG TERM ENGAGEMENT NOT SUSTAINED FOR MOST DEVICES



Declining Rate of Sustained Activity Tracker Use Over Ownership

(Endeavour Partners, September 2013)

BMJ. 2016; 355: i6270.
Published online 2016 Dec 13. doi: 10.1136/bmj.i6270
Christmas 2016: Being Well
PMCID: PMC5154977

Gotta catch'em all! Pokémon GO and physical activity among young adults: difference in differences study

- Effect of Pokémon GO on steps/day for 6 wks
- Online survey (n = 1182), age 18 – 35 yrs
- Primary outcome: Change in steps/day

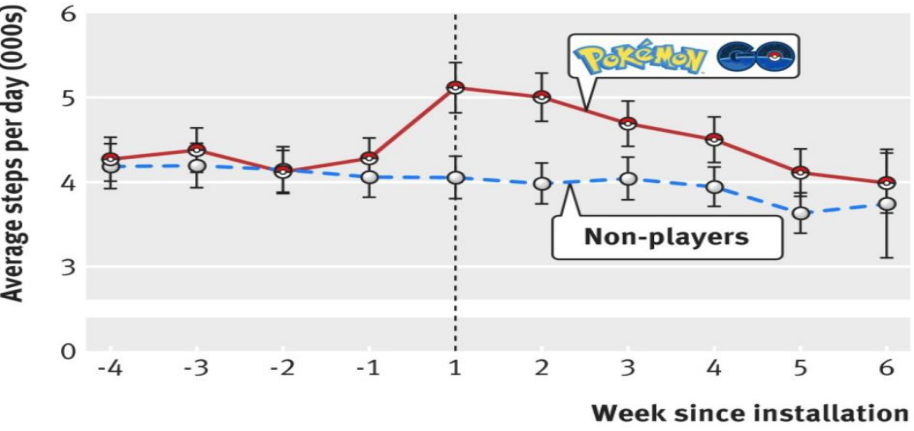


Fig 1 Average number of daily steps and 95% confidence intervals by week before and after installation of Pokémon GO (median 8 July 2016)

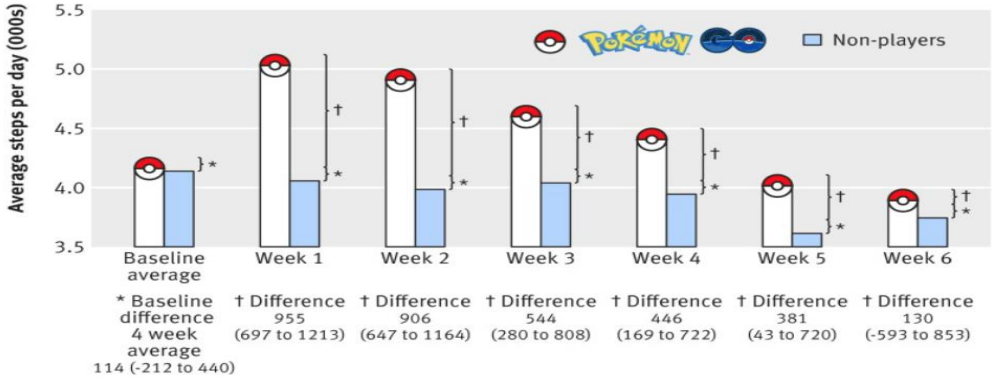
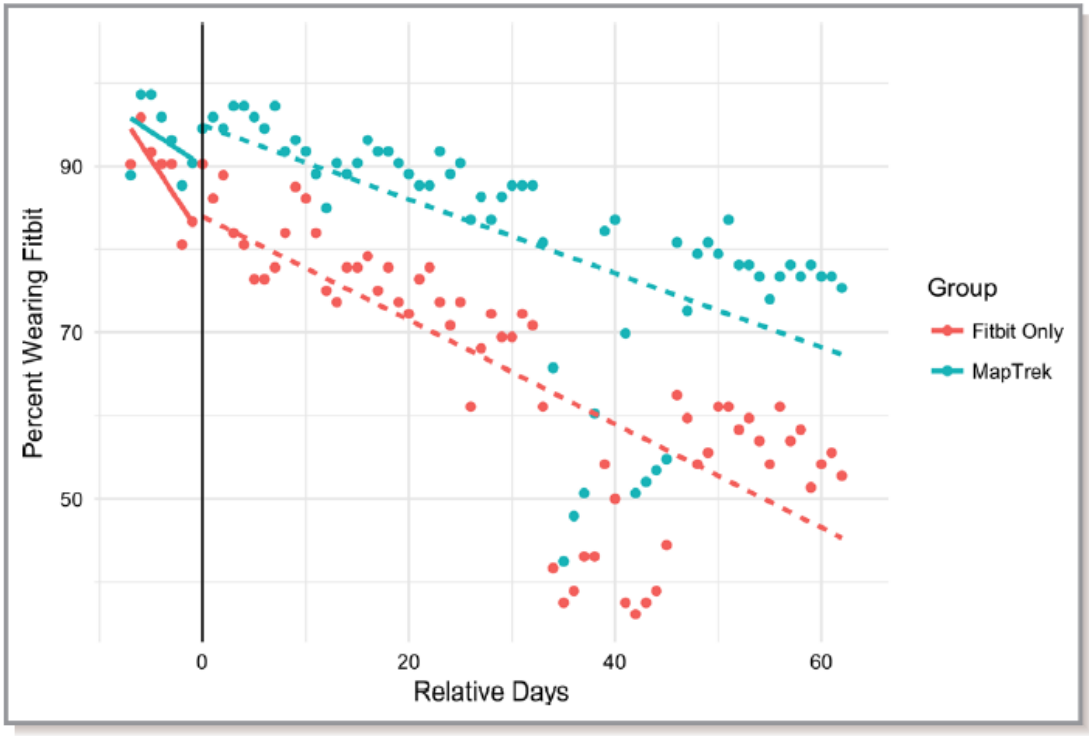


Fig 2 Average daily number of steps before and after installation of Pokémon GO (median 8 July 2016). Confidence intervals are estimated using a difference in difference regression model (see supplementary table 1 for the full model)

ORIGINAL RESEARCH

Gamifying Accelerometer Use Increases Physical Activity Levels of Sedentary Office Workers

J Am Heart Assoc. 2018;7:e007735.



- 146 sedentary office workers
- Fitbit vs Fitbit + Game (MapTrek)
- Fitbit + MapTrek group significantly increased
  → daily steps (+ 2092 steps/day)
  → active minutes (+ 11.2 min/day)
- Effect decreases over time

Criteria driving initial adoption & utilisation

- Selectability
- Design
- OOB Experience
- Fit / Comfort
- Durability
- User experience
- API
- Lifestyle compatibility
- Overall utility

Factors for long term engagement

- Habit formation
- Social motivation
- Goal reinforcement

ENDEAVOUR PARTNERS

ADVICE FOR USERS/CONSUMERS

- Keep it simple
- Don’t be too ambitious
- You should like the device from the beginning
- Incorporate into daily life

“Hi, I’ve reached my daily steps target, can you come and pick me up?”

Stay tuned for SPCRS 2019 (End-October)!

National University Heart Centre, Singapore
A member of the NUHS

@TJ_Yeo

www.nuhcs.com.sg

www.youtube.com/user/NUHCS

www.facebook.com/NUHCS

Questions welcome

THANK YOU