

Online Supplementary Data

Appendix 1. Search terms used in Embase, PubMed, and Web of Science databases.

Embase	Web of Science	Pubmed
<p>Wearables and smartphone</p> <p>('wearable electronic devices'/exp OR 'wearable electronic devices' OR wearable* OR smartwatch* OR (('smart'/exp OR 'smart') AND watch*) OR (('smart'/exp OR smart) AND band*) OR (('smart'/exp OR smart) AND bracelet*) OR 'smartphone'/exp OR 'smartphone' OR smartphone*)</p>	<p>Wearables and smartphone</p> <p>ALL FIELDS: (wearable* OR smartwatch* OR "smart watch" OR "smart watches" OR smartphone* OR (smart AND band*) OR (smart AND bracelet*))</p>	<p>Wearables and smartphone</p> <p>("Wearable Electronic Devices"[Mesh] OR wearable* OR smartwatch* OR (smart AND watch*) OR (smart AND band*) OR (smart AND bracelet*) OR "Smartphone"[Mesh] OR smartphone*)</p>
<p>Outcome</p> <p>AND (step*)</p>	<p>Outcome</p> <p>AND (step*)</p>	<p>Outcome</p> <p>AND (step*)</p>
<p>Study design</p> <p>AND ('reproducibility of results'/exp OR 'reproducibility of results' OR 'validity'/exp OR 'validity' OR 'validation'/exp OR 'validation' OR validate OR 'comparison'/exp OR 'comparison' OR 'reliability'/exp OR 'reliability' OR reliable)</p>	<p>Study design</p> <p>AND (validity OR validation OR validate OR comparison OR reliability OR reliable)</p>	<p>Study design</p> <p>AND ("Reproducibility of Results"[Mesh] OR validity OR validation OR validate OR comparison OR reliability OR reliable)</p>

Appendix 2. QUADAS-2 methodology, criteria for the risk of bias assessment, and the percentage of studies meeting these criteria.

As advised by the QUADAS-2 guidelines, a series of signalling questions were developed by the consortium members. The risk of bias assessment was conducted by three authors whereby each author independently rated two-thirds of the papers using a cross-over methodology to ensure each paper was reviewed by two authors. Any discrepancies were resolved by arbitration with the third author. Once a consensus was agreed upon, each study was given a risk of bias rating (high, low, or unclear) for each of the four headings (patient selection, index measure, criterion measure, and study flow and timing). If all signalling questions for a domain were answered “yes” then risk of bias was deemed to be “low”. If any signalling question was answered “no”, then risk of bias was deemed to be ‘high’. The “unclear” category was only used when insufficient data were reported to permit a judgment¹.

Criteria items	N studies meeting criterion		
	Laboratory (N=57)	Semi-free (N=9)	Free-living (N=30)
Domain 1: Patient Selection			
1. Did the study avoid inappropriate exclusions?	42 (74%)	9 (100%)	24 (80%)
Domain 2: Index measure			
2. Was the wearable/ smartphone used in its ecological context?	47 (82%)	8 (89%)	28 (93%)
Domain 3: Criterion measure			
3. Is the reference standard a 'Gold standard'?	29 (51%)	4 (44%)	1 (3%)
Domain 4: Flow and timing			
4. Did they provide adequate information about data synchronization?	16 (28%)	3 (33%)	8 (27%)
5. Did all participants receive the same reference standard?	53 (93%)	9 (100%)	29 (97%)
6. Were all participants included in the analysis or appropriate exclusion reasons were provided?	45 (79%)	9 (100%)	21 (70%)

Appendix 3. Summary of the validation methodologies used in the laboratory-condition studies (N = 57).

N ^o	Author	Population N (age \pm SD or range; % girls)	Testing Protocol	Criterion Measure	Index Measure; Placement	Data Synchro.	Statistics
1	Åkerberg et al. 2016 ²	Healthy adults 20 (30-61; 55%)	Walking in sloping and flat surfaces, and climbing stairs	Visual observation	Smartphone; Special vest to hold the phone	Data collected simultaneously	Hypo. and relative error
2	Alsubheen et al. 2016 ³	Healthy adults 13 (40.0 \pm 11.9; 38%)	Treadmill walking	Video	Activity tracker; Wrist	Data collected simultaneously	Hypo.
3	An et al. 2017 ⁴	Healthy adults 35 (31.0 \pm 11.8; 51%)	Treadmill walking and running	Visual observation	Activity trackers; Arm, wrist or waist	Data collected simultaneously	B&A, equivalence test, corr. and MAPE
4	Arch et al. 2017 ⁵	Unilateral transtibial amputation 50 (58.1 \pm 10.5; 28%)	Overground walking tests	Visual observation	Activity tracker; Attached to prosthesis	ND	RR, corr., regr. and APE
5	Ata et al 2018 ⁶	Peripheral Artery Disease 182 (69.5 \pm 13.1; 23%)	6 minute walk test	Visual observation	Smartphone; Hand, pocket and purse/bag	ND	B&A and regr.
6	Balmain et al 2019 ⁷	Healthy adults 36 (21.0 \pm 1.0; 53%)	Treadmill and overground walking	Video	Smartphone & smart clothing; Right hip and feet	ND	B&A and regr.
7	Balto et al 2016 ⁸	Multiple sclerosis 45 (47.7 \pm 10.0; ND)	Treadmill walking	Visual observation with ≥ 2 observers	Smartphones & activity trackers; Pocket and wrist	ND	Corr. and MPE
8	Beltrán-Carrillo et al 2019 ⁹	Healthy adults 16 (28.8 \pm 8.9; 50%)	Overground walking on straight track	Video	Smartphones; Waist, arm and hand	Wear time and/or task time considered	B&A, hypo., corr., RMSE and RB
9	Block et al 2019 ¹⁰	Multiple Sclerosis 61 (50.0 \pm 14.2; 72%)	2 min walk test	Visual observation	Activity trackers; Non-dominant wrist	ND	B&A, hypo., RR and regr.
10	Brodie et al 2018 ¹¹	Healthy adults 48 (28.8 \pm 8.9; 58%)	Overground walking	Visual observation	Smartphone; Phone fixed at the posterior hip	ND	Hypo. and APE
11	Buckinx et al 2017 ¹²	Healthy adults 24 (46.3 \pm 3.6; 50%)	Treadmill walking	Video	Activity trackers; Right ankle and right hip	ND	RR
12	Bunn et al 2019 ¹³	Healthy adults 24 (26.5 \pm 11.5; 50%)	Treadmill walking	Video with ≥ 2 observers	Activity trackers; Manufacturers' guidance	Data collected simultaneously	Hypo., Equiv., MPE
13	Burton et al 2018 ¹⁴	Healthy adults 31 (74.2 \pm 5.8; 65%)	Overground walking	Video with ≥ 2 observers	Activity trackers; Wrist	ND	Hypo. and RR

14	Chandrasekar et al 2018 ¹⁵	Polymyalgia rheumatica 31 (69.2 ± 8.8; 89%)	Overground walking	Video with ≥2 observers	Activity trackers; Right hip and midline of the shirt	Wear time and/or task time considered	B&A, corr. and MAPE
15	Clay et al 2019 ¹⁶	Stroke patients 21 (65.6 ± 8.2; 58%)	Overground walking	Video with ≥2 observers	Activity tracker; Waist band of non-paretic side	ND	B&A, RR, corr. and regr.
16	De Ridder et al 2019 ¹⁷	Crutch walking 30 (24.9 ± 5.3; 50%)	Overground walking	Visual observation with ≥2 observers	Activity trackers; Both wrists and waist	ND	B&A, hypo., RR and % bias
17	Duncan et al 2018 ¹⁸	Healthy adults 33 (25.9 ± 9.4; 67%)	Treadmill walking	Video with ≥2 observers	Smartphones; ND	Wear time and/or task time considered	B&A, hypo., RR and regr.
18	Ebara et al 2017 ¹⁹	Healthy adults 5 (31.2 ± 8.5; 0%)	Overground walking	Visual observation	Smartphones; Bust strap around chest	ND	B&A, hypo., RR and corr.
19	Floegel et al 2017 ²⁰	Adults with different fitness level 99 (78.9 ± 8.6; 71%)	Overground walking	Video with ≥2 observers	Activity trackers; Non-dominant hip and wrist	Wear time and/or task time considered	B&A, Equiv., RR, MAPE and MPE
20	Fokkema et al 2017 ²¹	Healthy adults 31 (32.0 ± 12.0; 48%)	Treadmill walking	Video	Activity trackers and smartphone; Wrist, hip and pocket	Data collected simultaneously	B&A, RR and regr.
21	Gaz et al 2018 ²²	Healthy adults 32 (35.8 ± 7.8; 48%)	Treadmill walking	Visual observation with ≥2 observers	Activity trackers; Dominant wrist and hip	Data collected simultaneously	GLMM
22	Hernández-Belmonte et al 2019 ²³	Healthy adults 10 (ND; 0%)	Overground walking, jogging and running	Video	Activity tracker; Upper back	Data collected simultaneously	B&A, RR and corr.
23	Höchsmann et al 2018 ²⁴	Healthy adults 20 (18-70; 70%)	Treadmill and overground walking and running with different inclinations and stairs	Video	Activity trackers and smartphones; Non-dominant wrist, pocket and strapped in the arm	Data collected simultaneously	MAPE
24	Huang et al 2016 ²⁵	Healthy adults 40 (23.6 ± 2.1; 25%)	Treadmill and overground walking and stair test	Video with ≥2 observers	Activity trackers; Both wrists	Data collected simultaneously	B&A, hypo. and MAPE
25	Hurt et al 2018 ²⁶	Healthy adults 57 (28.3 ± 9.9; 46%)	Overground walking	Visual observation	Smartphones; Frontal pocket	Data collected simultaneously	Corr. and GLMM
26	Johnson et al 2016 ²⁷	Healthy adults 29 (21.7 ± 1.6; 52%)	Overground walking	Research grade wearable device	Smartphones; Held in the hand and right pocket	Task time considered	B&A, hypo. and corr.

27	Jones et al 2018 ²⁸	Healthy adults 30 (33.0 ± 8.0; 60%)	Treadmill jogging and running	Video	Activity trackers; Both wrists	Data collected simultaneously	RR, MAPE and standard error
28	Kendall et al 2019 ²⁹	Healthy adults 50 (25.8 ± 8.1; 50%)	Maximal treadmill test	Visual observation	Activity trackers; Both wrists and right hip	Data collected simultaneously	Hypo. and RR
29	Lamont et al 2018 ³⁰	Mild-moderate Parkinson's Disease 33 (69.0 ± 8.1; 50%)	Walking in different surfaces	Research grade wearable device	Activity trackers; Both wrists	Data collected simultaneously	B&A, hypo., RR and MAPE
30	Lebleu et al 2020 ³¹	Healthy adults 60 (23.4 ± 1.3; 48%)	Overground walking circuit	Research grade wearable device	Smartphone; Both wrists and non-dominant hip	Data collected simultaneously	B&A, RR and MAPE
31	Leong et al 2017 ³²	Healthy adults 48 (19-25; 73%)	Treadmill walking	Visual observation	Smartphone; Right pocket	Data collected simultaneously	RR, corr. and MAPE
32	Liew et al 2020 ³³	Healthy adults 24 (23-30; 50%)	Overground walking	Visual observation	Activity tracker; Wrist	Data collected simultaneously	RR, corr. and MAPE
33	Lu et al 2017 ³⁴	ND	Overground walking in different directions	Visual observation	Smartphone; Waist holder, pocket, backpack or hands	Data collected simultaneously	MAPE
34	Magistro et al 2018 ³⁵	Healthy older adults 60 (75.0 ± 7.0; 50%)	Overground walking and stairs test	Video	Activity trackers; Both wrists	Data collected simultaneously	B&A, RR and APE
35	Major et al 2016 ³⁶	Healthy adults 20 (28.0 ± 5.0; 50%)	Overground walking	Video	Smartphone; Right pocket	Data collected simultaneously	B&A, RR and corr.
36	Massouh et al 2019 ³⁷	Cesarean delivery patients 48 (32.0 ± 6.0; 100%)	Overground walking	Visual observation	Activity trackers; Non-dominant wrist	Data collected simultaneously	B&A, RR and corr.
37	Montes et al 2018 ³⁸	ND 49 (23.4 ± 6.7; 48%)	Treadmill walking	Visual observation	Smart shirt; Worn as normal	Data collected simultaneously	RR and corr.
38	Montoye et al 2017 ³⁹	Healthy adults 32 (23.5 ± 1.3; 44%)	Treadmill walking and running, lying, standing, sitting and cycling	Research grade wearable device	Smart shirt and activity tracker; Shirt worn as normal and tracker on non-dominant wrist	Synchro. issues mentioned but not discussed	B&A, hypo., corr. and MAPE
39	Munck et al 2018 ⁴⁰	Healthy adults 22 (27.0 ± 7.3; 50%)	Treadmill walking	ND	Activity trackers; Wrist	ND	MPE
40	Orr et al 2015 ⁴¹	ND 29 (27.1 ± 8.3; ND)	Overground and treadmill walking	Video and participant counted their own steps	Smartphones; Held in participants' hands	ND	Hypo.

41	Pepa et al 2017 ⁴²	Healthy adults 22 (22-30; 27%)	Overground walking	Research grade wearable device	Smartphone; Lateral side of the hip and posterior pelvis	Jump used as synchro.	Hypo. and corr.
42	Polese et al 2019 ⁴³	Stroke patients 37 (62.0 ± 11.0; 24%)	Overground walking	Video	Smartphone; Front pockets of the participants' paretic leg	ND	Corr.
43	Presset et al 2018 ⁴⁴	ND 37 (30-60; 35%)	Treadmill walking	Research grade wearable device	Smartphone; Attached to the belt, the biceps and a jacket	ND	B&A
44	Psaltos et al 2019 ⁴⁵	Healthy adults 40 (34.8 ± 10.2; 53%)	Overground walking	Research grade wearable device	Activity trackers and smartphones; Trackers: wrist, phones: attached to 4 th lumbar vertebrae	ND	B&A and corr.
45	Rüdiger et al 2019 ⁴⁶	Healthy adults 32 (74.8 ± 5.9; 56%)	Overground walking	Visual observation and research grade wearable device	Activity tracker; Non-dominant arm	ND	B&A and corr.
46	Schaffer et al 2017 ⁴⁷	Stroke patients 24 (54.0 ± 13.4; 42%)	Overground walking	Video	Activity trackers; Wrists of both paretic and non-paretic arms	ND	B&A and hypo.
47	Schmal et al 2018 ⁴⁸	Post-operative patients 22 (81.0 ± 8.0; 50%)	ND	Video	Activity trackers; Wrist and ankle	ND	Corr.
48	Smith et al 2019 ⁴⁹	Lower-limb prosthesis users 32 (49.7 ± 14.0; 34%)	Overground walking	Visual observation	Activity trackers; Both wrists	Wear and task time considered	Hypo.
49	Tam et al 2018 ⁵⁰	Healthy adults 30 (32.1 ± 8.7; 50%)	Treadmill walking	Video with ≥2 observers	Activity trackers; Non-dominant wrist	ND	Corr.
50	Tedesco et al 2019 ⁵¹	Healthy older people 18 (69.0 ± 3.2; 61%)	Treadmill walking	Video	Activity trackers; Both wrists	Synchro. issues mentioned but not discussed	MAPE, MPE, RMSE, AME, MAD
51	Thorup et al 2017 ⁵²	Healthy adults and cardiac patients 44 (53.0 ± 7.4; 27%)	Treadmill walking	Research grade wearable device	Activity tracker; Elastic belts, two at the heart level and two at the waist	ND	RB
52	Tophøj et al 2018 ⁵³	Healthy adults 20 (25.6 ± 2.0; 50%)	Treadmill walking	Visual observation	Activity trackers; Non-dominant wrist	ND	MAPE and MAD

53	Van Oeveren et al 2018 ⁵⁴	Healthy adults 22 (28.0 ± 2.9; 41%)	Overground walking	Video	Smartphones; Pocket, strapped to the arm and the back waist	Jump used as synchro.	Hypo.
54	Veerabhadrapa et al 2018 ⁵⁵	Healthy adults 71 (18-55; 34%)	Treadmill walking	Video	Activity tracker; Left wrist	Wear and task time considered	Corr.
55	Wahl et al 2017 ⁵⁶	Healthy adults 20 (26.1 ± 2.8; 50%)	Treadmill and overground walking	Research grade wearable device	Activity trackers; Armband and backside of the pelvis. Other trackers ND	ND	B&A, RR, MAPE and TE
56	Wong et al 2018 ⁵⁷	Healthy adults 25 (25.0 ± 6.7; 48%)	Treadmill walking	Video	Activity tracker; Right hip	Wear and task time considered	Hypo.
57	Xie et al 2018 ⁵⁸	Healthy adults 44 (22.2 ± 2.2; 48%)	Overground walking and running	Video	Activity trackers and smartphones; Both wrists and pocket	Synchro. issues mentioned but not discussed	Corr. and MAPE

Abbreviations. Synchro.: synchronization; ND: Not disclosed; SD: standard deviation.

Statistics code. B&A: Bland & Altman; Hypo.: hypothesis test; Equiv.: equivalence test; RR: relative reliability; Corr.: correlation; Regr.: regression; MAPE: mean absolute percentage error; APE: absolute percentage error; MPE: mean percentage error; RMSE: root-mean-square deviation; RB: relative bias; AME: absolute mean error; %bias: percentage of bias; GLMM: generalized linear mixed model; MAD: median absolute difference; SEM: standard error of measurement; TE: typical error.

Appendix 4. Summary of the validation methodologies used in the semi-free-living studies (N = 9).

N ^o	Author	Population N (age \pm SD or range; % girls)	Testing Protocol	Criterion Measure	Index Measure; placement	Data Synchro.	Statistics
1	Bai et al 2018 ⁵⁹	Healthy adults 41 (32.0 \pm 11.0; 38%)	Sedentary activities, aerobic exercise and household activities	Research grade wearable device	Activity trackers; Left wrist	ND	B&A, Equiv., corr., MAPE, MPE and RMSE and
2	Bort-Roig et al 2018 ⁶⁰	Healthy adults 17 (26.0 \pm 3.0; 59%)	Overground walking, stairs and work simulation	Research grade wearable device	Smartphone; Pouch in the mid-to-front point of the thigh	ND	RR and AME
3	Genovese et al 2017 ⁶¹	Healthy adults 8 (38.5 \pm 11.8; 38%)	Sedentary activities, ambulatory and household activities	Visual observation	Activity trackers; Non-dominant wrist and waist	Data collected simultaneously	RMSE and AME
4	Imboden et al 2018 ⁶²	Healthy adults 30 (69.5 \pm 13.1; 23%)	Sedentary, household and ambulatory activities	Visual observation	Activity trackers; Left hip and non-dominant wrist	Data collected simultaneously	B&A, hypo., corr. and MAPE
5	Nelson et al 2016 ⁶³	Healthy adults 30 (48.9 \pm 19.4; 50%)	Sedentary, household and ambulatory activities	Visual observation	Activity trackers; Left hip and non-dominant wrist	Data collected simultaneously	Hypo., MAPE, RMSE and MAE
6	O'Connell et al 2017 ⁶⁴	Healthy adults 37 (39.0 \pm 13.9; 68%)	Work simulation, vehicles, household and fitness activities	Video	Activity trackers; Both hips, right wrist and chest	Wear and task time considered	Regr.
7	Tedesco et al 2019 ⁶⁵	Healthy older adults 18 (69.3 \pm 2.8; 61%)	Daily life activities	Video	Activity trackers; Both wrists	Synchro. issues mentioned but not discussed	MAPE, MPE, RMSE, AME and MAD
8	Ummels et al 2018 ⁶⁶	Several diseases 130 (61.5 \pm 11.1; 58%)	Daily life activities	Video	Activity trackers and smartphones; Pocket and wrist	ND	B&A, 2 and 5
9	Wendel et al 2018 ⁶⁷	Parkinson's disease 33 (65.5 \pm 9.4; 42%)	Daily life activities	Video	Activity trackers; Left wrist and left hip	ND	B&A, 4, 7

Abbreviations. Synchro.: synchronization; ND: Not disclosed; SD: standard deviation.

Statistics code. B&A: Bland & Altman; Hypo.: hypothesis test; Equiv.: equivalence test; RR: relative reliability; Corr.: correlation; Regr.: regression; MAPE: mean absolute percentage error; APE: absolute percentage error; MPE: mean percentage error; RMSE: root-mean-square deviation; RB: relative bias; AME: absolute mean error; %bias: percentage of bias; GLMM: generalized linear mixed model; MAD: median absolute difference; SEM: standard error of measurement; TE: typical error.

Appendix 5. Summary of the validation methodologies used in the free-living studies (N = 30).

N ^o	Author	Population N (age \pm SD or range; % girls)	Testing Protocol	Criterion Measure	Index Measure; placement	Data Synchro.	Statistics
1	Amagasa et al 2019 ⁶⁸	Healthy adults 54 (31.0 \pm 10.0; 52%)	At home	Research grade wearable device	Smartphone; Carried as usual	Data collected simultaneously	B&A, hypo., RR, corr. and regr.
2	An et al 2017 ⁴	Healthy adults 35 (31.0 \pm 11.8; 51%)	24h of free-living	Research grade wearable device	Activity trackers; Upper arm, wrist and waist	Data collected simultaneously	B&A, equiv., corr. and MAPE
3	Arch et al 2018 ⁵	Unilateral transtibial amputation 50 (58.1 \pm 10.5; 28%)	7 days of free-living	Research grade wearable device	Activity tracker; Attached to the prosthesis	ND	RR, corr., regr. and APE
4	Block et al 2019 ¹⁰	Multiple Sclerosis 61 (54.0 \pm 11.4; 72%)	7 days of free-living	Research grade wearable device	Activity trackers; Non-dominant wrist	Wear time considered	B&A, hypo., RR and regr.
5	Bort-Roig et al 2018 ⁶⁰	Healthy adults 17 (26.0 \pm 3.0; 59%)	2h of free- living	Research grade wearable device	Smartphone; Pouch in the mid-to-front point of the thigh	ND	RR and B&Aequiv.
6	Burton et al 2018 ¹⁴	Healthy adults 31 (74.2 \pm 5.8; 65%)	14 days of free-living	Research grade wearable device	Activity tracker; Wrist	ND	Hypo. and RR
7	Chu et al 2017 ⁶⁹	Healthy adults 107 (26-42; 66%)	At least 4 days of free-living	Research grade wearable device	Activity tracker; Non-dominant wrist	Synchro. issues mentioned but not discussed	B&A, hypo., RR, corr. and MAPE
8	Collins et al 2019 ⁷⁰	Knee osteoarthritis patients 15 (68.0 \pm 8.0; 67%)	7 days of free-living	Research grade wearable device	Activity tracker; Non-dominant wrist	ND	RR and B&ARR
9	Degroote et al 2018 ⁷¹	Healthy adults 36 (39.4 \pm 17.8; 50%)	2 days of free-living	Research grade wearable device	Activity trackers; Non-dominant wrist	Wear time considered	B&A, RR and corr.
10	Dominick et al 2016 ⁷²	Healthy adults 19 (19-37; 79%)	14 days of free-living	Research grade wearable device	Activity tracker; Dominant wrist	Wear time considered	Hypo., corr. and B&Acorr.
11	Douma et al 2018 ⁷³	Cancer patients 89 (63.0 \pm 11.5; 38%)	7 days of free-living	Research grade wearable device	Smartphone; Pocket or attached to a belt	Wear time considered	B&A, RR and regr.
12	Duncan et al 2018 ¹⁸	Healthy adults 33 (25.9 \pm 9.4; 67%)	7 days of free-living	Research grade wearable device	Smartphone; ND	Wear time considered	B&A, hypo., RR and regr.

13	Ferguson et al 2015 ⁷⁴	Healthy adults 21 (32.8 ± 10.2; 52%)	2 days of free-living	Research grade wearable device	Activity trackers; Left wrist and right hip	Wear time considered	B&A, corr. and B&Aregr.
14	Gill et al 2018 ⁷⁵	Healthy adults 21 (30-65; 0%)	7 days of free-living	Research grade wearable device	Activity tracker; Pocket	Wear time considered	B&A, corr. and B&Aequiv.
15	Gomersall et al 2016 ⁷⁶	Healthy adults 32 (39.6 ± 11.0; 90%)	7 days of free-living	Research grade wearable device	Activity trackers; Belt, pocket and both wrists	Data collected simultaneously	B&A and corr.
16	Höchsmann et al 2020 ⁷⁷	Healthy adults 30 (23-32; 62%)	3 days of free-living	Research grade wearable device	Activity trackers and smartphones; Non-dominant wrist, both hips and pocket	Data collected simultaneously	B&A, RR and MAPE
17	Hartwig et al 2019 ⁷⁸	Healthy children and adolescents 592 (13.5 ± 0.5; 49%)	Physical education classes	Research grade wearable device	Activity tracker; Hip	Data collected simultaneously	B&A, corr. and regr.
18	Lebleu et al 2020 ³¹	Healthy adults 60 (39.4 ± 12.0; 0%)	24h of free-living	Research grade wearable device	Smartphones; Both wrists and hip on non-dominant side	Data collected simultaneously	B&A, RR and MAPE
19	Leong et al 2017 ³²	Healthy adults 48 (19-25; 73%)	7 days of free-living	Research grade wearable device	Smartphone; Pocket, right thigh and left arm	Data collected simultaneously	RR, corr. and MAPE
20	Liew et al 2020 ³³	Healthy adults 40 (23-30; 50%)	At least 4 days of free-living	Research grade wearable device	Activity tracker; Wrist	Data collected simultaneously	RR, corr. and B&Aregr.
21	Middelweerd et al 2017 ⁷⁹	Healthy adults 34 (23.9 ± 3.9; 68%)	7 days of free-living	Research grade wearable device	Activity tracker; Right hip with a waist belt	Data collected simultaneously and wear time considered	B&A, RR, APE and B&Acorr.
22	Mooses et al 2018 ⁸⁰	Healthy children 147 (9-10; 50%)	School ground	Research grade wearable device	Activity tracker; Hip	Data collected simultaneously	B&A, hypo. and corr.
23	Orr et al 2015 ⁴¹	ND 29 (27.1 ± 8.3; ND)	3 days of free-living	Research grade wearable device	Smartphones; Held in participant hands	Wear time considered	Hypo.
24	Rosenberger et al 2016 ⁸¹	ND 40 (21-876; 53%)	24h of free-living	Research grade wearable device	Activity trackers; Right wrist	Wear time considered	MAPE
25	Rozanski et al 2018 ⁸²	Stroke patients 37 (64.4 ± 15.9; 53%)	2 separated days of free-living	Research grade wearable device	Activity trackers; Wrist	ND	Hypo. and corr.

26	Stamatelopoulou et al 2018 ⁸³	ND 21 (ND;ND)	7 days of free-living	Research grade wearable device	Activity tracker and smartphone; Wrist and pocket or bag	ND	Corr.
27	Tedesco et al 2019 ⁶⁵	Healthy older adults 20 (70.6 ± 3.0; 55%)	1 days of free-living	Research grade wearable device	Activity trackers; Non-dominant wrist	ND	RR
28	Toth et al 2018 ⁸⁴	Healthy adults 12 (35.0 ± 13.0; 50%)	24h of free-living	Video with ≥2 observers	Activity trackers; Random wrist and left hip	Wear time considered	Hypo. and MAPE
29	Voss et al 2017 ⁸⁵	Congenital heart disease 40 (13.0 ± 2.2; 53%)	7 days of free-living	Research grade wearable device	Activity tracker; Manufactured guidelines	Wear time considered	B&A and RR
30	Yang et al 2019 ⁸⁶	Healthy adults 120 (13.0 ± 2.5; 52%)	7 days of free-living	Research grade wearable device	Activity tracker; Non-dominant wrist	ND	B&A, RR and corr.

Abbreviations. Synchro.: synchronization; ND: Not disclosed; SD: standard deviation.

Statistics code. B&A: Bland & Altman; Hypo.: hypothesis test; Equiv.: equivalence test; RR: relative reliability; Corr.: correlation; Regr.: regression; MAPE: mean absolute percentage error; APE: absolute percentage error; MPE: mean percentage error; RMSE: root-mean-square deviation; RB: relative bias; AME: absolute mean error; %bias: percentage of bias; GLMM: generalized linear mixed model; MAD: median absolute difference; SEM: standard error of measurement; TE: typical error.

Appendix 6. QUADAS-2 risk of bias for the laboratory based studies.

Article Number	Author	Patient Selection	Index measure	Criterion measure	Flow & Timing
1	Åkerberg et al. 2016 ²	Low	Low	High	Low
2	Alsubheen et al. 2016 ³	Low	Low	Low	High
3	An et al. 2017 ⁴	Low	Low	High	Low
4	Arch et al. 2017 ⁵	High	High	High	High
5	Ata et al 2018 ⁶	Low	Low	High	Low
6	Balmain et al 2019 ⁷	Low	Low	Low	High
7	Balto et al 2016 ⁸	Low	Low	High	High
8	Beltrán-Carrillo et al 2019 ⁹	Low	High	Low	High
9	Block et al 2019 ¹⁰	Low	Low	High	High
10	Brodie et al 2018 ¹¹	Low	High	High	High
11	Buckinx et al 2017 ¹²	Low	Low	Low	High
12	Bunn et al 2019 ¹³	Low	Low	Low	High
13	Burton et al 2018 ¹⁴	Low	Low	Low	High
14	Chandrasekar et al 2018 ¹⁵	Low	Low	Low	Low
15	Clay et al 2019 ¹⁶	Low	Low	Low	High
16	De Ridder et al 2019 ¹⁷	High	Low	High	High
17	Duncan et al 2018 ¹⁸	Low	Low	Low	High
18	Ebara et al 2017 ¹⁹	High	High	High	High
19	Floegel et al 2017 ²⁰	Low	Low	Low	High
20	Fokkema et al 2017 ²¹	Unclear	Low	Unclear	High
21	Gaz et al 2018 ²²	Low	Low	High	Low
22	Hernández-Belmonte et al 2019 ²³	Low	Low	Low	High
23	Höchsman et al 2018 ²⁴	Low	Low	Low	High
24	Huang et al 2016 ²⁵	Low	Low	Low	High
25	Hurt et al 2018 ²⁶	Low	Low	High	High
26	Johnson et al 2016 ²⁷	Low	Low	High	Low
27	Jones et al 2018 ²⁸	Low	Low	Low	High
28	Kendall et al 2019 ²⁹	Unclear	High	High	High
29	Lamont et al 2018 ³⁰	Low	Low	High	High
30	Lebleu et al 2020 ³¹	Low	Low	High	High
31	Leong et al 2017 ³²	Low	Low	High	High
32	Liew et al 2020 ³³	Low	Low	High	High
33	Lu et al 2017 ³⁴	High	High	High	High

34	Magistro et al 2018 ³⁵	Low	Low	Low	Low
35	Major et al 2016 ³⁶	Low	Low	Low	Low
36	Massouh et al 2019 ³⁷	Low	Low	High	High
37	Montes et al 2018 ³⁸	Unclear	Low	High	High
38	Montoye et al 2017 ³⁹	Low	Low	High	High
39	Munck et al 2018 ⁴⁰	Low	Low	High	High
40	Orr et al 2015 ⁴¹	Unclear	Low	Low	Low
41	Pepa et al 2017 ⁴²	Unclear	High	Low	High
42	Polese et al 2019 ⁴³	Low	Low	Low	High
43	Presset et al 2018 ⁴⁴	Unclear	Low	Low	High
44	Psaltos et al 2019 ⁴⁵	Unclear	High	Low	High
45	Rüdiger et al 2019 ⁴⁶	Low	Low	High	High
46	Schaffer et al 2017 ⁴⁷	Low	Low	Low	High
47	Schmal et al 2018 ⁴⁸	Low	Low	Low	High
48	Smith et al 2019 ⁴⁹	Low	Low	High	High
49	Tam et al 2018 ⁵⁰	Low	Low	Low	High
50	Tedesco et al 2019 ⁵¹	Low	Low	Low	Low
51	Thorup et al 2017 ⁵²	Low	Low	High	High
52	Tophøj et al 2018 ⁵³	Unclear	Low	High	High
53	Van Oeveren et al 2018 ⁵⁴	Unclear	Low	Low	Low
54	Veerabhadrapa et al 2018 ⁵⁵	Low	Low	Low	Low
55	Wahl et al 2017 ⁵⁶	Unclear	High	Low	High
56	Wong et al 2018 ⁵⁷	Low	Low	Low	Low
57	Xie et al 2018 ⁵⁸	Low	Low	Low	High
High/unclear Risk of Bias Count		14	9	26	44
% High Risk of Bias		25%	16%	46%	77%

Appendix 7. QUADAS-2 risk of bias for the semi-free-living studies.

Article Number	Author	Patient Selection	Index measure	Criterion measure	Flow & Timing
1	Bai et al 2018 ⁵⁹	Low	Low	High	High
2	Bort-Roig et al 2018 ⁶⁰	Low	High	High	High
3	Genovese et al 2017 ⁶¹	Low	Low	High	High
4	Imboden et al 2018 ⁶²	Low	Low	High	High
5	Nelson et al 2016 ⁶³	Low	Low	High	Low
6	O'Connell et al 2017 ⁸⁷	Low	Low	Low	Low
7	Tedesco et al 2019 ⁶⁵	Low	Low	Low	Low
8	Ummels et al 2018 ⁶⁶	Low	Low	Low	High
9	Wendel et al 2018 ⁶⁷	Low	Low	Low	High
High/unclear Risk of Bias Count		0	1	5	6
% High Risk of Bias		0%	11%	56%	67%

Appendix 8. QUADAS-2 risk of bias for the free-living studies.

Article Number	Author	Patient Selection	Index measure	Criterion measure	Flow & Timing
1	Amagasa et al 2019 ⁶⁸	Low	Low	High	High
2	An et al 2017 ⁴	Low	Low	High	High
3	Arch et al 2018 ⁵	High	High	High	High
4	Block et al 2019 ¹⁰	High	Low	High	High
5	Bort-Roig et al 2018 ⁶⁰	Low	High	High	High
6	Burton et al 2018 ¹⁴	Low	Low	High	High
7	Chu et al 2017 ⁶⁹	Low	Low	High	High
8	Collins et al 2019 ⁷⁰	Low	Low	High	High
9	Degroote et al 2018 ⁷¹	Low	Low	High	High
10	Dominick et al 2016 ⁷²	Low	Low	High	Low
11	Douma et al 2018 ⁷³	Low	Low	High	High
12	Duncan et al 2018 ¹⁸	Low	Low	High	High
13	Ferguson et al 2015 ⁷⁴	Low	Low	High	High
14	Gill et al 2018 ⁷⁵	Low	Low	High	Low
15	Gomersall et al 2016 ⁷⁶	Low	Low	High	High
16	Höchstmann et al 2020 ⁷⁷	Low	Low	High	High
17	Hartwig et al 2019 ⁷⁸	Unclear	Low	High	High
18	Lebleu et al 2020 ³¹	Low	Low	High	High
19	Leong et al 2017 ³²	Low	Low	High	High
20	Liew et al 2020 ³³	Low	Low	High	High
21	Middelweerd et al 2017 ⁷⁹	Low	Low	High	Low
22	Mooses et al 2018 ⁸⁰	High	High	High	Low
23	Orr et al 2015 ⁴¹	Low	Low	High	Low
24	Rosenberger et al 2016 ⁸¹	Unclear	Low	High	High
25	Rozanski et al 2018 ⁸²	Low	Low	High	High
26	Stamatelopoulou et al 2018 ⁸³	Unclear	Low	High	High
27	Tedesco et al 2019 ⁶⁵	Low	Low	High	High
28	Toth et al 2018 ⁸⁴	Low	Low	Low	Low
29	Voss et al 2017 ⁸⁵	Low	Low	High	Low
30	Yang et al 2019 ⁸⁶	Low	Low	High	High
High Risk of Bias Count		6	3	29	23
% High Risk of Bias		20%	10%	97%	77%

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