

Evaluating the Effectiveness of Gamification on Physical Activity: Systematic Review and Meta-analysis of Randomized Controlled Trials

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Multimedia Appendix 1: Supplementary Materials

1. Supplemental figures referred in the manuscript
2. Search equations for databases

All Data and materials are available on the OSF page of the project (<https://osf.io/x2483/>)

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1. Supplemental figures referred in the manuscript

Table S1 Keywords used for database searches

Physical activity and sedentary behaviors	Gamification	e-health	iOS	Trial
exercise	gamification	telemedicine	iOS	
sport	exergaming	telehealth	android	“randomized
“active living”	game	e-health	website	controlled
“active transport”	gamified	m-health	digital*	trial”
“exercise therapy”	gaming	mobile	electronic*	RCT
fitness	gameful*	internet	device	randomized
sedent*	multiplayer	applications	framework*	trial
“sitting time”	player	smartphone	wearable	“clinical trial”
inactive	playing	cellphone	“social	“controlled
inactivity		Iphone	network”	trial”
walk*		facebook	Technolog*	

N.B. Some additional terms and synonyms could be used for some database. For more information, see search strings for each database.

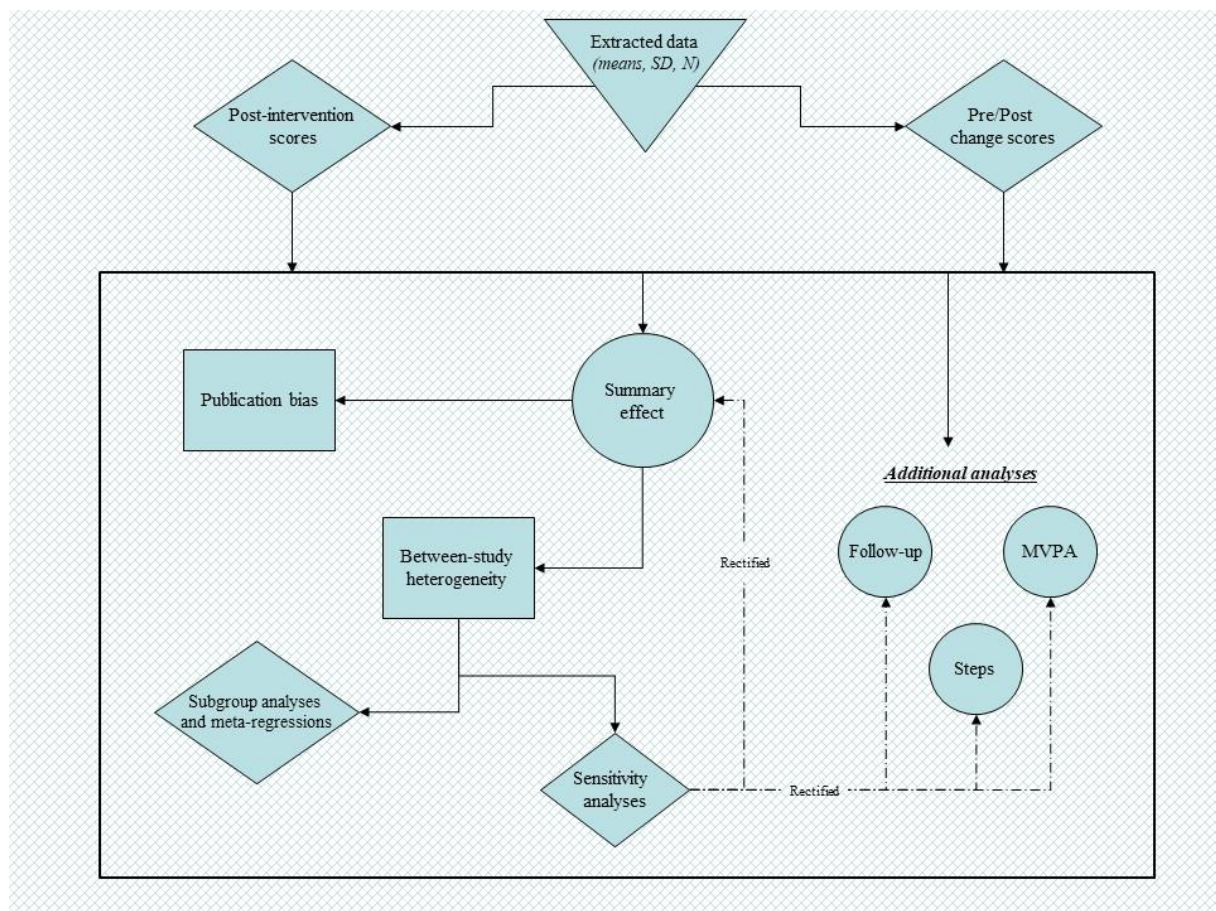


Fig. S1 Statistical analyses summary. All analyses were conducted two times, both for post-intervention scores and for pre/post intervention change scores

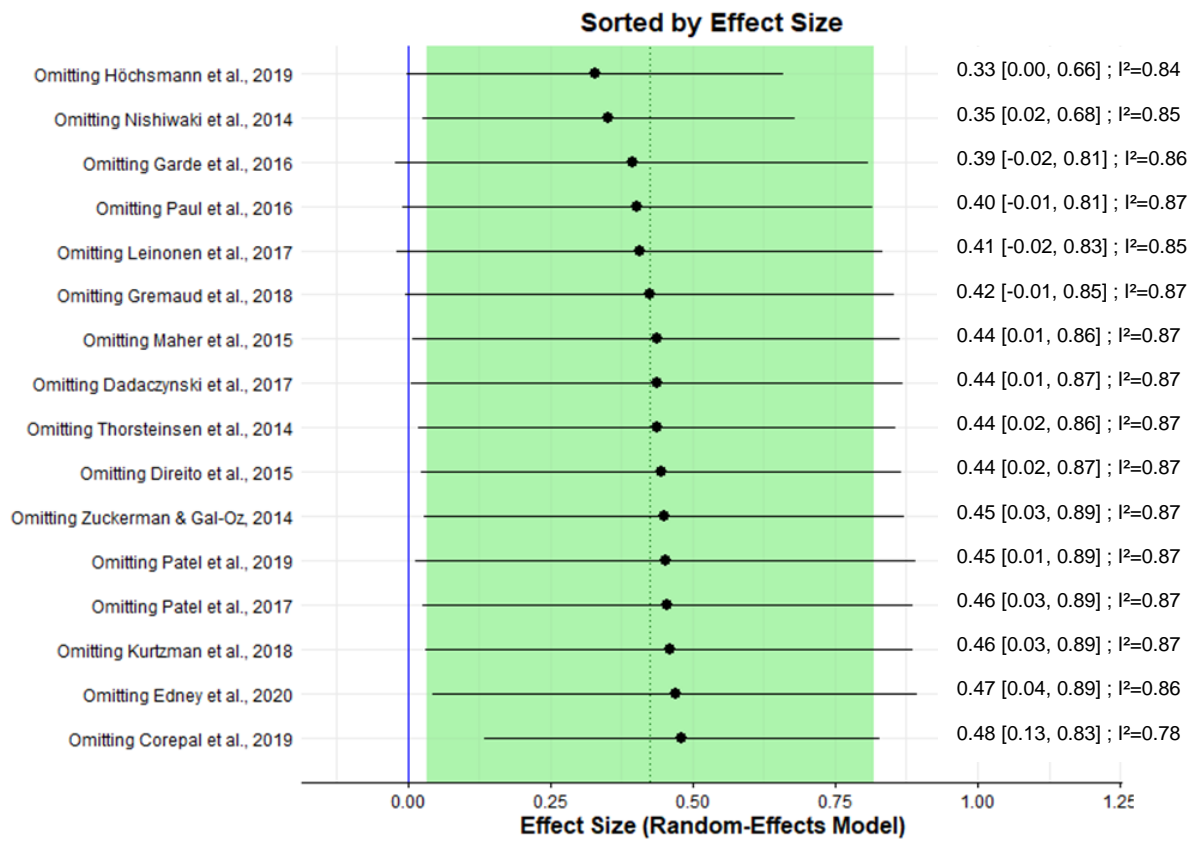


Fig. S2 Forest plots representing Leave-one-out analyses ordered by effect size (Hedge's *g*; low to high)

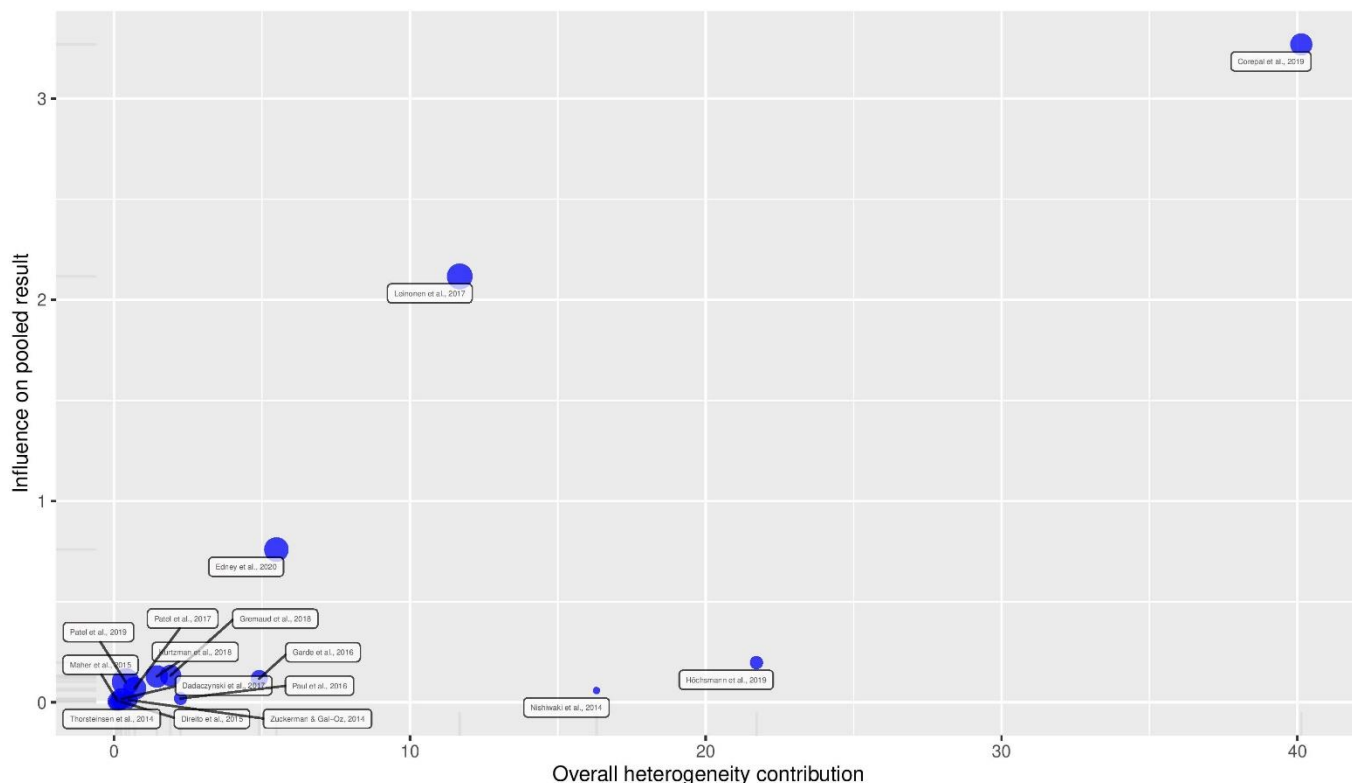


Fig. S3 Baujat plot representing the contribution of each study to the overall heterogeneity (measured by Cochran’s Q) in function of its influence on the pooled effect size

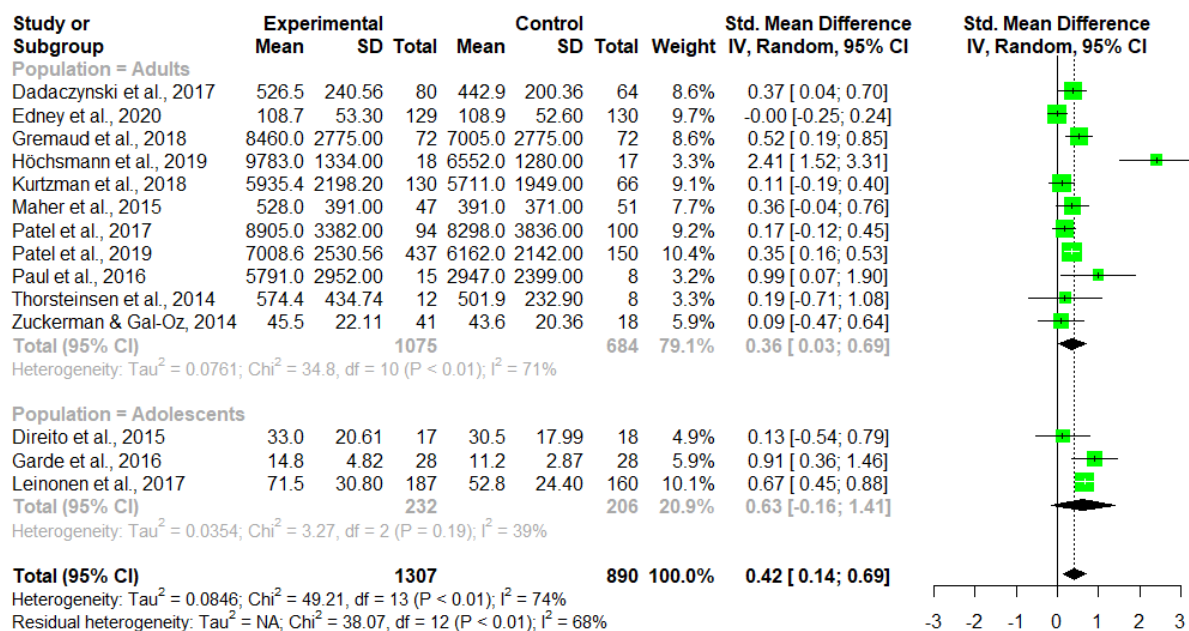


Fig. S4 Forest plot with age subgroups (adults versus adolescents) for the effect of gamification versus control on post-intervention PA outcomes (moderate-to-vigorous physical activity)

(MVPA), daily step count, number of active minutes, and walking time). *SD* standard deviation, *Std* standardized, *IV* inverse variance, *CI* confidence interval, *Tau*², *Chi*², and *I*² measures of between-study heterogeneity

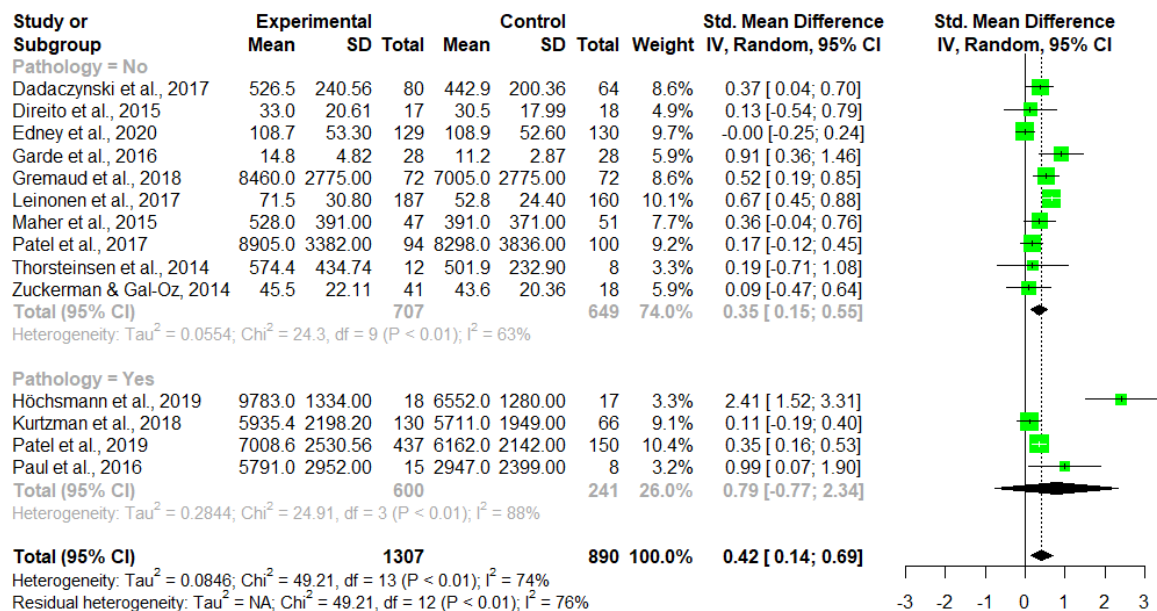


Fig. S5 Forest plot with health condition subgroups (healthy people versus patients with chronic diseases) for the effect of gamification versus control on post-intervention PA outcomes (moderate-to-vigorous physical activity (MVPA), daily step count, number of active minutes, and walking time). *SD* standard deviation, *Std* standardized, *IV* inverse variance, *CI* confidence interval, *Tau*², *Chi*², and *I*² measures of between-study heterogeneity

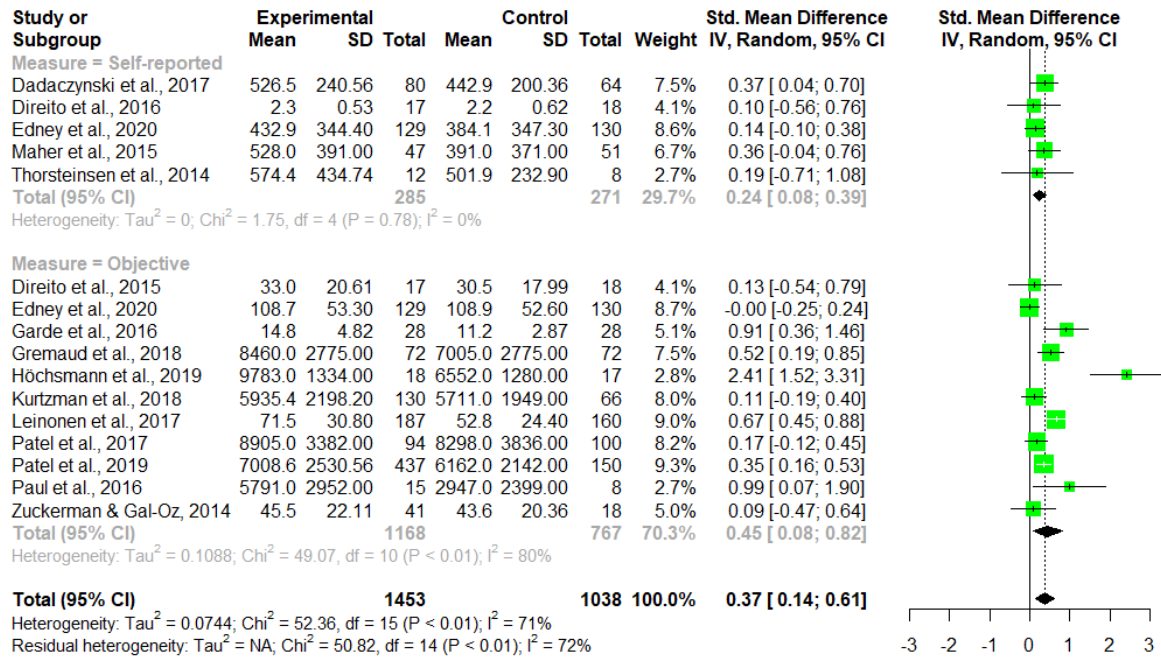


Fig. S6 Forest plot with type of measure subgroups (self-reported versus objective measures) for the effect of gamification versus control on post-intervention PA outcomes (moderate-to-vigorous physical activity (MVPA), daily step count, number of active minutes, and walking time). *SD* standard deviation, *Std* standardized, *IV* inverse variance, *CI* confidence interval, *Tau*², *Chi*², and *I*² measures of between-study heterogeneity

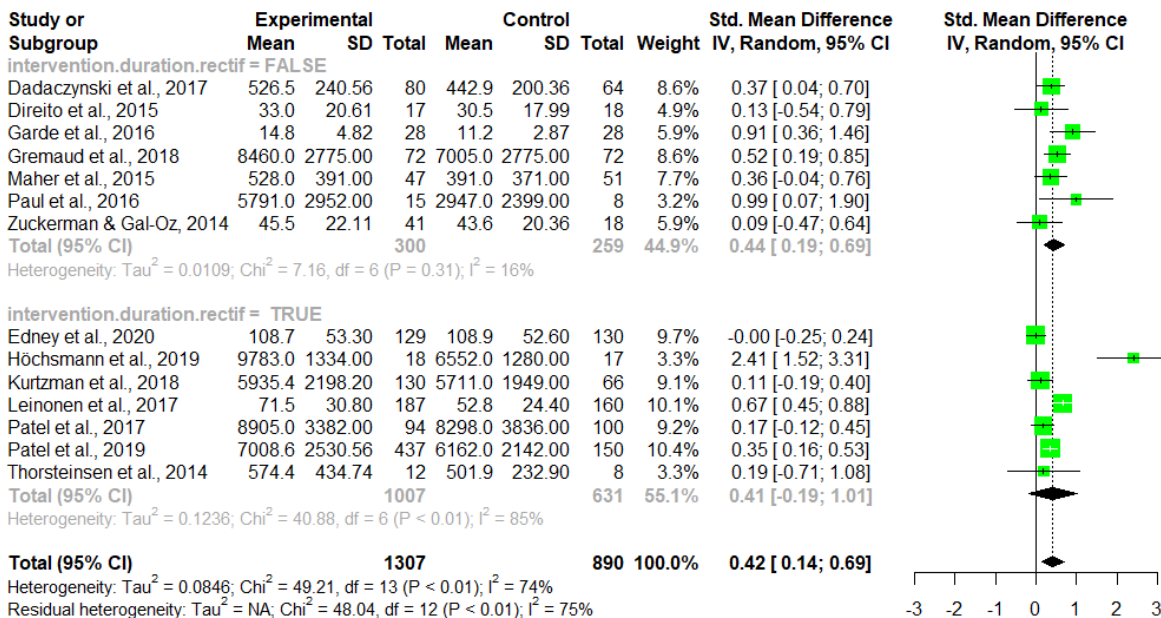


Fig. S7 Forest plot with subgroups in function of intervention duration (less than 12 weeks versus 12 weeks or more) for the effect of gamification versus control on post-intervention PA outcomes (moderate-to-vigorous physical activity (MVPA), daily step count, number of active

minutes, and walking time). *SD* standard deviation, *Std* standardized, *IV* inverse variance, *CI* confidence interval, *Tau*², *Chi*², and *I*² measures of between-study heterogeneity

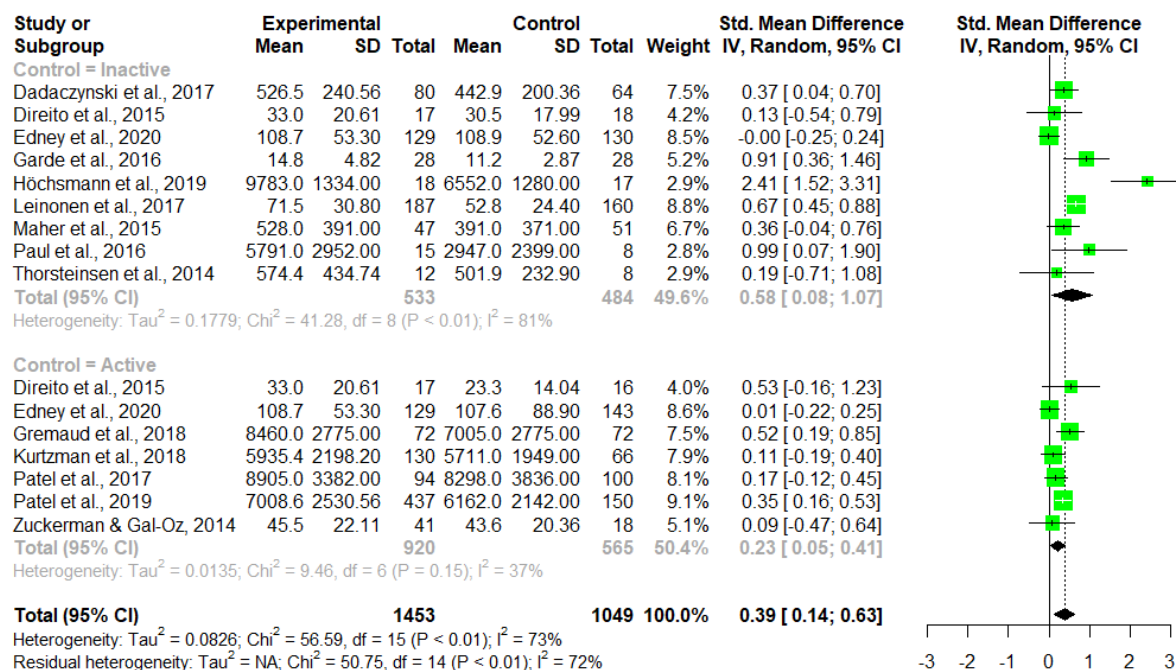


Fig. S8 Forest plot with control groups subgroups (inactive control group versus active control group) for the effect of gamification versus control on post-intervention PA outcomes (moderate-to-vigorous physical activity (MVPA), daily step count, number of active minutes, and walking time). *SD* standard deviation, *Std* standardized, *IV* inverse variance, *CI* confidence interval, *Tau*², *Chi*², and *I*² measures of between-study heterogeneity

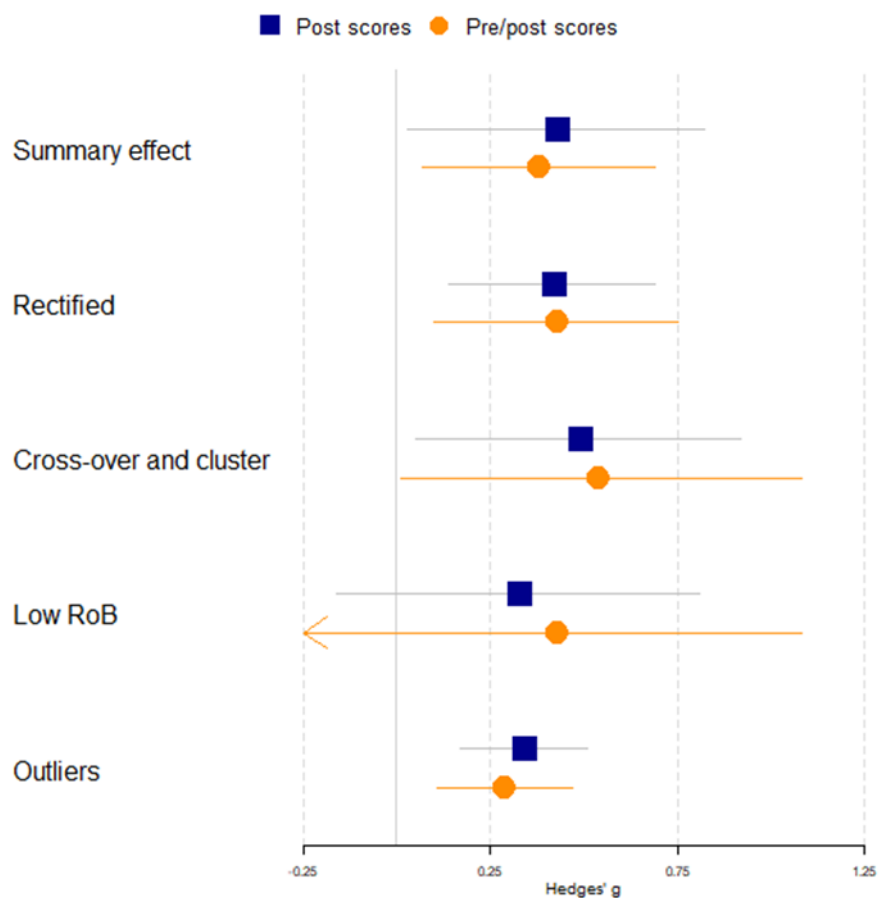


Fig. S9 Summary of the meta-analyses conducted on global PA (i.e., summary effect of gamification versus control, rectified effect after ‘sensitivity analysis’, effect after removing cross-over and cluster trials, effect after removing studies with a high Risk of Bias (RoB), and effect after removing outliers) both for post-intervention scores and pre/post intervention change scores

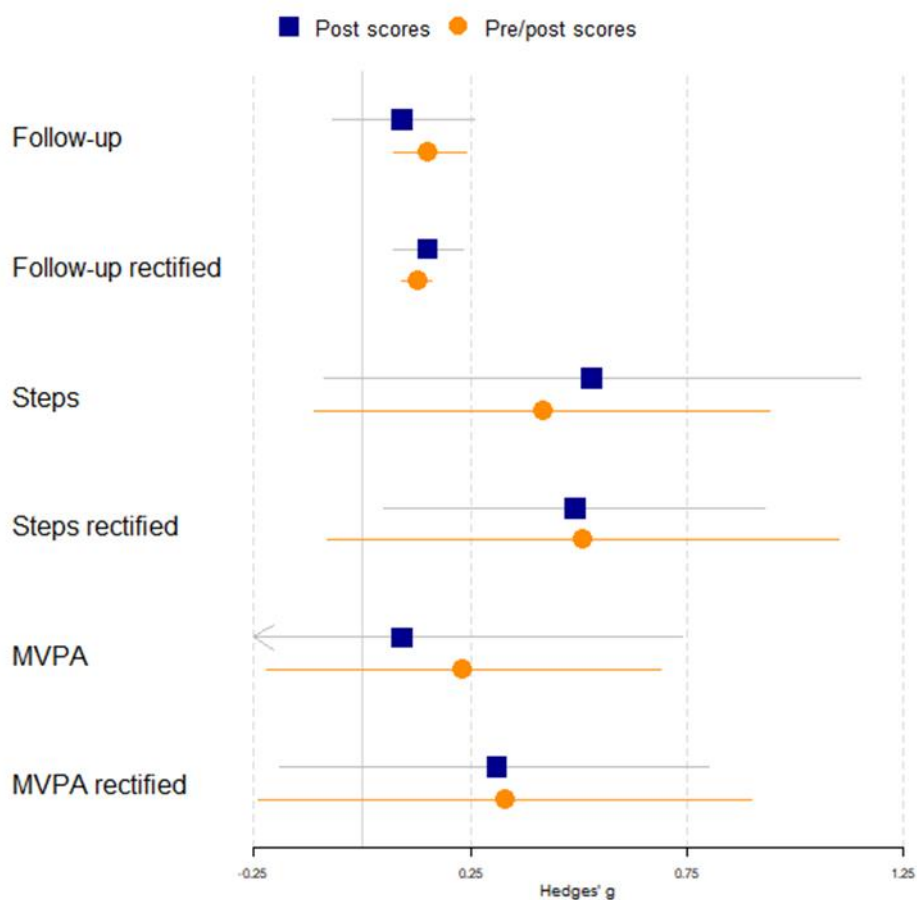


Fig. S10 Summary of the meta-analyses conducted on other outcomes (i.e., effect of gamification versus control after a follow-up period (from 12 to 24 weeks after the end of the intervention), effect on steps outcomes, effect on moderate-to-vigorous physical activity (MVPA), and rectified effects after ‘sensitivity analyses’) both for post-intervention scores and pre/post intervention change scores

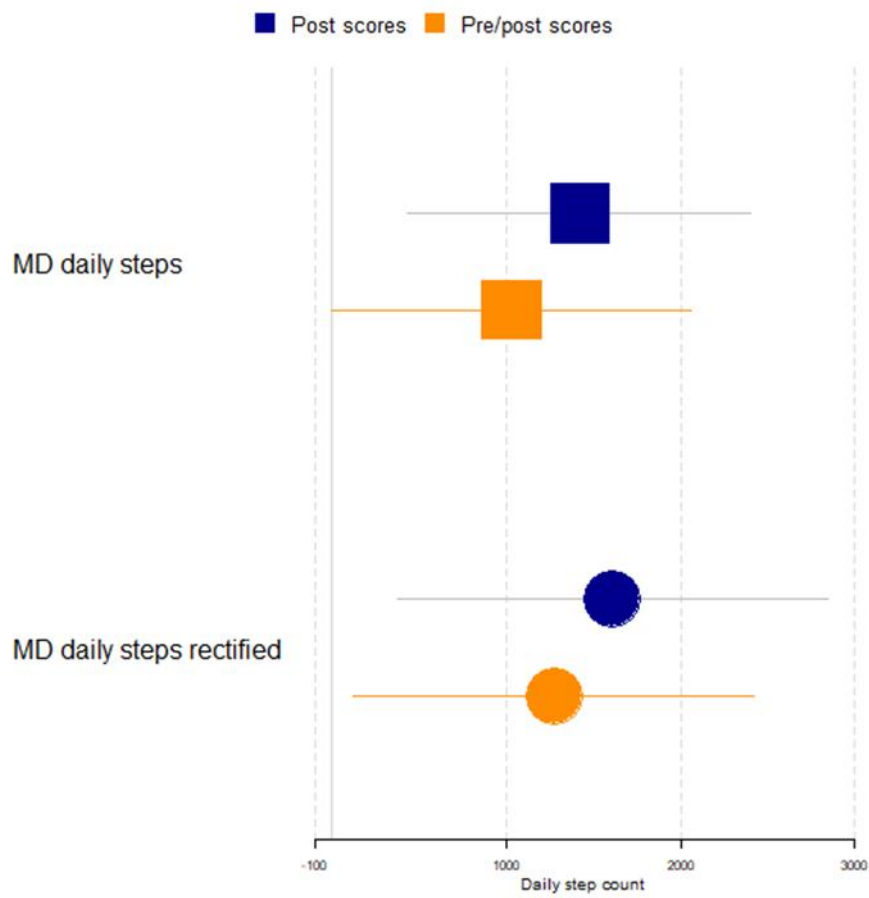


Fig. S11 Summary of the meta-analyses conducted on daily steps (i.e., mean difference of daily steps between gamification and control) both for post-intervention scores and pre/post intervention change scores

2. Search equations for databases

Search String PubMed (615)

- #1. ("exercise"[MH] OR "exercise"[TW] OR "exercises"[TW] OR "active living"[TW] OR "active transport"[TW] OR "activities, physical"[TW] OR "activity, physical"[TW] OR "physical activities"[TW] OR "physical activity"[TW] OR "exercise therapy"[MH] OR "physical fitness"[MH] OR fitness[TW] OR sedent*[TW] OR "sitting time"[TW] OR inactive[TW] OR inactivity[TW] OR walk*[TW])
- #2. (gamification[TW] OR exergaming[TW] OR "exer-gaming"[TW])
- #3. (randomized controlled trial[pt] OR controlled clinical trial[pt] OR randomized[tiab] OR clinical trials as topic[mesh:noexp] OR randomly[tiab] OR trial[ti])
- #4. #1 AND #2 AND #3
- #5. (game[TW] OR games[TW] OR gamified[TW] OR gaming[TW] OR gameful*[TW] OR multiplayer[TW] OR player[TW] OR players[TW] OR playing[TW])
- #6. ("telemedicine"[MH] OR "telemedicine"[TW] OR "telehealth"[TW] OR e-health[TW] OR m-Health[TW] OR eHealth[TW] OR mHealth[TW] OR "mobile applications"[MH] OR "applications"[TW] OR "application"[TW] OR app[TW] OR apps[TW] OR "online"[TW] OR "mobile"[TW] OR "internet"[TW] OR "web based"[TW] OR "Smartphone"[MH] OR "phone, smart"[TW] OR "smart phones"[TW] OR "smartphones"[TW] OR "smart phone"[TW] OR "phones, smart"[TW] OR "Smartphone"[TW] OR "cell phone"[TW] OR Iphone[TW] OR android[TW] OR iOS[TW] OR "Wearable Electronic Devices"[MH] OR website[TW] OR digital*[TW] OR system*[TW] OR electronic*[TW] OR technolog*[TW] OR device[TW] OR framework*[TW] OR "social support"[Mesh:NoExp] OR "facebook"[TW] OR "networks, social"[TW])
- #7. #1 AND #3 AND #5 AND #6
- #8. #4 OR #7

Filters: English, from 2010-2020

Search String EMBASE (491)

('sport'/exp OR 'exercise'/exp OR 'physical activity' OR 'climbing'/exp OR 'walking'/exp OR 'sitting'/exp) AND ('exergame'/exp OR 'exergaming'/exp OR 'active video game'/exp OR exergam*:ti,ab,kw OR 'active video gam*:ti,ab,kw OR 'active videogam*:ti,ab,kw OR 'active computer gam*:ti,ab,kw OR 'gamification'/exp OR 'gamifi*:ti,ab,kw OR (('recreational game'/exp OR 'game-based':ti,ab,kw OR 'gam*:ti,ab,kw) AND ('telehealth'/exp OR 'mobile application'/exp OR 'smartphone'/exp OR 'wearable computer'/exp OR 'social network'/exp OR 'virtual reality'/exp))) AND ('clinical trial'/de OR 'controlled clinical trial'/de OR 'randomized controlled trial'/de OR 'randomized controlled trial topic'/de) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim)

Search String CENTRAL (1602)

- #1. ("exercise":ti,ab,kw OR "exercises":ti,ab,kw OR "active living":ti,ab,kw OR "active transport":ti,ab,kw OR "activities, physical":ti,ab,kw OR "activity, physical":ti,ab,kw OR "physical activities":ti,ab,kw OR "physical activity":ti,ab,kw OR fitness:ti,ab,kw OR sedent*:ti,ab,kw OR "sitting time":ti,ab,kw OR inactive:ti,ab,kw OR inactivity:ti,ab,kw OR walk*:ti,ab,kw)
- #2. (gamification:ti,ab,kw OR exergaming:ti,ab,kw OR "exer-gaming":ti,ab,kw)
- #3. #1 AND #2
- #4. (game:ti,ab,kw OR games:ti,ab,kw OR gamified:ti,ab,kw OR gaming:ti,ab,kw OR gameful*:ti,ab,kw OR multiplayer:ti,ab,kw OR player:ti,ab,kw OR players:ti,ab,kw OR playing:ti,ab,kw)
- #5. ("telemedicine":ti,ab,kw OR "telehealth":ti,ab,kw OR "e-health":ti,ab,kw OR "m-Health":ti,ab,kw OR "eHealth":ti,ab,kw OR "mHealth":ti,ab,kw OR "applications":ti,ab,kw OR "application":ti,ab,kw OR app:ti,ab,kw OR apps:ti,ab,kw OR "online":ti,ab,kw OR "mobile":ti,ab,kw OR "internet":ti,ab,kw OR "web based":ti,ab,kw OR "phone, smart":ti,ab,kw OR "smart phones":ti,ab,kw OR "smartphones":ti,ab,kw OR "smart phone":ti,ab,kw OR "phones, smart":ti,ab,kw OR "Smartphone":ti,ab,kw OR "cell phone":ti,ab,kw OR Iphone:ti,ab,kw OR android:ti,ab,kw OR iOS:ti,ab,kw OR website:ti,ab,kw OR digital*:ti,ab,kw OR system*:ti,ab,kw OR electronic*:ti,ab,kw OR technolog*:ti,ab,kw OR device:ti,ab,kw OR framework*:ti,ab,kw OR "facebook":ti,ab,kw OR "networks, social":ti,ab,kw OR "social network":ti,ab,kw OR "network, social":ti,ab,kw OR "social support":ti,ab,kw OR "support, social":ti,ab,kw OR "social networking":ti,ab,kw OR virtual*:ti,ab,kw)
- #6. #1 AND #4 AND #5
- #7. #3 OR #6

Limit: Publication Year from 2010 to 2020 in Trials.

Search String Scopus (306)

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(( TITLE ("physical activity" OR sport OR exercise? OR walking OR fitness OR "active living" OR "active transport" OR sedent* OR "sitting time" OR inactiv* OR ( physical AND near/1 AND activit* )) ) AND ( TITLE-ABS-KEY ( "randomi?ed controlled trial" OR "randomi?ed clinical trial" OR "controlled clinical trial" OR randomi?ed OR rct ) ) AND ( TITLE-ABS-KEY ( gamifi* OR exergam* OR "exer-gam*" ) ) ) OR ( ( TITLE ( "physical activity" OR sport OR exercise? OR walking OR fitness OR "active living" OR "active transport" OR sedent* OR "sitting time" OR inactiv* OR ( physical AND near/1 AND activit* ) ) ) AND ( TITLE-ABS-KEY ( "randomi?ed controlled trial" OR "randomi?ed clinical trial" OR "controlled clinical trial" OR randomi?ed OR rct ) ) AND ( TITLE-ABS-KEY ( game? OR multiplayer OR player? OR playing OR play ) ) AND ( TITLE-ABS-KEY ( telemedicine OR telehealth OR "e-health" OR "m-Health" OR ehealth OR "mHealth" OR application? OR app? OR online OR mobile OR internet OR "web based" OR "phone, smart" OR "smart phones" OR "smartphones" OR "smart phone" OR "phones, smart" OR "Smartphone" OR "cell phone" OR iphone OR android OR "iOS" OR website OR digital* OR system* OR electronic* OR technolog* OR device OR framework* OR "facebook" OR "networks, social" OR "social network" OR "network, social" OR "social support" OR "support, social" OR "social networking" OR virtual* ) ) ) AND ( LIMIT-TO
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Search String Web of Science (89)

- #1. TI = ("physical activity" OR sport OR exercise? OR walking OR fitness OR "active living" OR "active transport" OR sedent* OR "sitting time" OR inactive OR inactivity OR (physical NEAR/1 activit*))
- #2. TI = (gamifi* OR exergam* OR exer-gam*)
- #3. TS= ("clinical trial*" OR "controlled trial*" OR "follow-up stud*" OR "prospective stud*" OR "random*" OR "single blind*" OR "double blind*" OR rct)
- #4. #1 AND #2 AND #3
- #5. TS= (telemedicine OR telehealth OR e-health OR m-Health OR eHealth OR mHealth OR application? OR app? OR online OR mobile OR internet OR "web based" OR "phone, smart" OR "smart phones" OR "smartphones" OR "smart phone" OR "phones, smart" OR "Smartphone" OR "cell phone" OR Iphone OR android OR "iOS" OR website OR digital* OR system* OR electronic* OR technolog* OR device OR framework* OR facebook OR "networks, social" OR "social network" OR "network, social" OR "social support" OR "support, social" OR "social networking" OR virtual*)
- #6. TI = (game? OR multiplayer OR player? OR playing OR play)
- #7. #1 AND #3 AND #5 AND #6
- #8. #4 OR #7