One small step for man, one giant leap for men's health: a meta-analysis of behaviour change interventions to increase men's physical activity

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ABSTRACT

Objective To determine the effects of behaviour change interventions on men's physical activity (postintervention), sustained change in physical activity behaviour (≥12 months postintervention) and to identify variations in effects due to potential moderating variables (eg, theoretical underpinning, gender-tailored, contact frequency).

Design Systematic review with meta-analysis. Pooled effect size (Cohen's *d*) was calculated assuming a random-effects model. Homogeneity and subsequent exploratory moderator analyses were assessed using Q, T^2 and I^2.

Data sources Medline, EMBASE, CINAHL, SportDiscus and Web of Science to April 2019.

Eligibility criteria for selected studies Randomised control trials of behaviour change interventions in men (≥18 years) where physical activity was an outcome and data were from men-only studies or disaggregated by sex.

Results Twenty-six articles described 24 eligible studies. The overall mean intervention effect on men's physical activity was 0.35 (SE=0.05; 95% CI 0.26 to 0.45; p<0.001). This effect size is consistent with an increase of approximately 97 min of total physical activity per week or 980 steps per day. Intervention moderators associated with greater increases in physical activity included objective physical activity outcome measures, a gender-tailored design, use of a theoretical framework, shorter length programmes (≤12 weeks), using four or more types of behaviour change techniques and frequent contact with participants (≥1 contact per week). 12 studies included additional follow-up assessments (≥12 months postintervention) and the overall mean effect was 0.32 (SE=0.09; 95% CI 0.15 to 0.48; p<0.001) for that sustained increase in physical activity.

Summary Behaviour change interventions targeting men's physical activity can be effective. Moderator analyses are preliminary and suggest research directions.

INTRODUCTION

Physical activity is important in disease prevention and illness management and there has been considerable research into effective physical activity interventions.[1,2] Although gender is recognised as an important sociocultural factor influencing health and health-related behaviours,[3] its influence on the uptake of behavioural interventions is not well understood.

Worldwide, women live for almost 6 years longer than men and men have higher rates of all-cause mortality for many conditions.[4] Factors associated with these sex differences are men's alignments to health compromising, masculine roles, identities and relations.[5] These expressions of masculinities intersect with other social determinants of health (eg, socioeconomic status, race) to marginalise some subgroups of men, creating significant health inequities. Consequently, some men lack the knowledge and/or resources to promote their health and/or access health services and may be less willing to attend health education sessions than women.[6–9] It is often assumed that men cannot or will not access health promotion programmes, and that programmes designed for the general public will suffice for those men who are willing to attend.

Evaluations of health promotion programmes often fall short in providing information about effective strategies to promote men's health because of the under representation of men. For example, in a meta-analysis demonstrating a small effect for adult physical activity interventions (*d*=0.19), only 26% of participants within the included studies were men,[2] making generalisability challenging. As approximately 31% of the population worldwide is insufficiently active,[10] and clinically relevant health benefits may be accrued through relatively small increases in physical activity,[11] millions of men stand to benefit from effective health promotion interventions.

To yield the full health benefits of being physically active, behaviour must be sustained over time. A limited number of studies include additional follow-up measures postintervention and the evidence for long-term behaviour change is mixed.[12–14] A Cochrane review investigating the effectiveness of interventions for promoting self-reported physical activity found that intervention effects postintervention (*d*=0.28) were not maintained in 6 of the 19 studies reporting outcomes after 6 months.[12] Two more recent reviews examining the effects of web-based and face-to-face interventions reported small effects at 12 months postintervention (*d*=0.20, 0.19, respectively) and either no or small effects at 24 months. However, most studies failed to measure the long-term (ie, ≥12 months) effects on physical activity.[13,14]

Developments in men's health promotion have resulted in an increased number of physical activity interventions targeted at engaging and retaining men.[15,16] Several strategies and approaches (eg, men-only programmes, 'masculine' setting) have been identified that show promise for improving men's participation, retention and overall success rates.[15–20] Interventions tailored specifically to the values, preferences and interests of men (eg, gender-tailored) may increase programme effectiveness.[15] Despite the growing interest in men's health promotion, the overall effectiveness of physical activity interventions for men remains unclear. The aim of our meta-analysis was to determine the effects of behaviour change interventions to increase men's physical activity, sustained physical activity change (≥12 months postintervention) and to identify how potential moderating variables were associated with key outcomes (eg, theoretical underpinning, gender-tailored, contact frequency).

METHODS

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) Statement (online supplementary table S1)[21] and was prospectively registered in the PROSPERO registry of systematic reviews (#CRD42018079448).

Inclusion criteria

Eligible studies for inclusion were randomised controlled trials (RCTs) identified using the following framework:

1. *Population*. Studies included adult men age 18+ years. Mixed sex studies were included provided relevant data (see outcomes) for men were reported separately. Consistent with previous research,[15 16] studies that exclusively included older adults (≥65 years) were excluded as they are likely to have different intervention requirements.
2. *Intervention*. Interventions with clear and deliberate intent to increase the physical activity levels of participants. Physical activity was defined as any bodily movement that increased energy expenditure beyond basal levels.[2] Diverse physical activity behaviour change interventions were eligible (eg, education sessions, supervised physical activity practice sessions). Articles that included both physical activity and other health behaviours (eg, diet) were included, provided that physical activity change was an intended and explicitly reported outcome.
3. *Comparison*. Studies were RCTs.
4. *Outcomes*. An outcome measure of physical activity (eg, steps per day, total activity minutes per week), disaggregated by sex (if applicable), available for both intervention and control groups, representing physical activity change from prepoint to postpoint or multipoint test.

Search method

A comprehensive search strategy was undertaken to identify all possible studies for inclusion. The search was applied to MEDLINE and adapted for EMBASE, CINAHL, SportDiscus and Web of Science. All searches were completed by a specialised research librarian (MVD) to April 2019. Search terms included MeSH and keywords relevant to the aims and in accordance with the eligibility criteria: (1) population (eg, Male/ or (men or male?)); (2) intervention (eg, Exercise/ or ("physical activit*" or exercis*)) and (3) outcomes (eg, Fitness Trackers/ or Self Report/). Additional filters were used to limit results to RCTs (eg, Randomized Controlled Trial/ or (randomi#ed or experimental) adj3 trial). Searches were limited to English language, original research and academic journals. No editorials, reviews, commentaries, conference abstracts or other grey literature were included. The decision to not include grey literature was based on concerns relating to the absence of peer-review and the potential for identifying an unrepresentative sample of all unpublished studies. The reference lists of included articles were manually searched for potential studies not yet identified. See online supplementary table S2 for the complete search syntax. Prior to manuscript submission, identified articles were reviewed to ensure that no trial had been retracted between inclusion and publication.[22]

Screening of articles

All identified references were imported into EndNote X8 (Clarivate Analytics, Philadelphia, Pennsylvania, USA). Duplicates were automatically identified by matches in authorship, year and title and manually reviewed prior to deletion. Overseen by the lead author (PS), two trained research assistants performed a title and abstract review to screen remaining records for relevance. Full text articles were retrieved for all remaining records and further screened to identify the final set of articles for inclusion. Any uncertainty was discussed among the research team.

Data extraction, study quality and quality of evidence

A coding framework was developed, pilot tested and refined by two researchers (PS and JCS). Study characteristics were coded by two reviewers (PS and JCS) under four general categories relating to the study design (eg, sample size, physical activity measurement), participants (eg, mean age, health status), intervention (eg, mode of delivery, behaviour change techniques, theoretical underpinning) and results (eg, mean change, SD). Outcome data for use in the meta-analysis were recorded for baseline, immediately postintervention and 12 months or greater postintervention. If more than one variable was available for physical activity, the variable that best reflected an overall measure of physical activity was selected (eg, total MET-minutes, self-reported total physical activity). Interventions were coded using Michie and colleagues'[23] definitions for characterising behaviour change interventions including education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement. Relevant detail was sought from additional publications (eg, protocol papers), when available. Interventions were deemed to be gender-tailored if there was evidence to suggest that they were designed specifically to the values, preferences and interests of men. Intervention engagement was assessed as high (>80%), moderate (60%–80%) or low (<60%) based on participants' average reported uptake of the intervention content (eg, attendance, website visits) or the extent to which participants met reported engagement goals (eg, % attending 10 of 12 sessions). The coding framework is not exhaustive of all intervention aspects and only common comparable characteristics reported in sufficient detail across studies are subsequently reported on.

Study quality was independently assessed by two members of the research team (PS and CMC) using The Effective Public Health Practice Project (EPHPP) tool.[24] This tool has been reported to have content and construct validity, excellent interrater reliability and is recommended by the Cochrane Pubic Health Review Group for assessing the quality of public health and health promotion studies.[25–27] This six-domain (14 question) rating scale for interventions assesses selection bias, study design, assessment of confounders, data collection methods (reliability and validity) and reporting of blinding, withdrawals and dropouts. In accordance with the tool's guidelines, a score for each domain of weak (1 point), moderate (2 points) or strong (3 points) was awarded and averaged to provide a total score for each study. Based on their total score, studies are assigned a quality rating of weak (1.00–1.50), moderate (1.51–2.50) or strong (2.51–3.00). Where discrepancies existed between reviewers, deliberation occurred until consensus was reached.

Additionally, the overall quality of evidence was assessed by three members of the research team (PS, CMC and JLB) using GRADE.[28 29] The quality of evidence was performed for each study outcome (ie, physical activity change and long-term physical activity change) and reflects the extent to which we are confident that an estimate of the effect is correct. The quality of evidence can be assessed as high, moderate, low or very low. As all studies were randomised trials, study quality is initially assumed to be high but can be rated down based on risk of bias, inconsistency of results, indirectness of evidence, imprecision or publication bias.

Statistical methods

Standardised mean differences (ie, effect size) with 95% CIs were computed to represent the effect of the interventions on men's physical activity. A positive effect size indicates a more favourable change in physical activity for the intervention condition. Cohen's criteria were used for interpretation of effect sizes as small (<0.50), moderate (0.50–0.79) and large (>0.79).[30] In addition, estimates of mean physical activity effect sizes were converted to the original metrics of ambulatory steps per day and minutes per week. Effect sizes were calculated using change from baseline scores, as this method removes a component of between-person variability from the analysis by controlling for preintervention differences.[31] In some cases, the required statistics were not reported. If available, and if possible, change scores were calculated from pretest and post-test means and SD, means and SEs, CI or other statistics (eg, p values), using conventional methods detailed by Borenstein *et al*.[32] In studies that included multiple intervention groups, a pooled mean and SD was calculated to create a single pair-wise comparison before entering the meta-analysis. Cluster-randomised trials were adjusted for using an estimation of the sample size.[33] In such instances, a design effect was calculated for each study using an intracluster correlation coefficient of 0.05, which has been previously used in meta-analyses of physical activity trials.[34–37]

Comprehensive meta-analysis V.3 software was used for all analyses. A random effects model with inverse variance weighting was applied to estimate the pooled effect for physical activity. Two overall effect size calculations were conducted to investigate the effect of interventions on men's physical activity (baseline to postintervention) and long-term physical activity change (baseline to 12 month or greater postintervention). Each study contributed one effect size calculation to the overall analysis and 12 studies reported an additional follow-up measure 12 months or greater postintervention. Sensitivity analysis was conducted using the 'one-study remove' procedure. Publication bias was analysed using Egger's regression test,[38] Duval and Tweedie's Trim and Fill Procedure[39] and Rosenthal's Fail-Safe N calculation.[40] Homogeneity of effects was assessed through the Q-statistic. A significant Q-within (Q_w) value indicates a heterogeneous distribution and suggests a need to conduct follow-up moderator analyses. To interpret heterogeneity, Tau-squared (T^2), an estimate of total variance between studies, and I-squared (I^2), a ratio of excess dispersion to total dispersion, were calculated. Larger T^2 values reflect the proportion of variance that can be attributed to real differences between studies. I^2 can be understood as the overlap of CIs explaining the total variance attributed to the covariates, interpreted as low (25%), moderate (50%) and high (75%) relative variance. Larger I^2 values require techniques (ie, moderator analysis or meta-regression) to provide explanations.

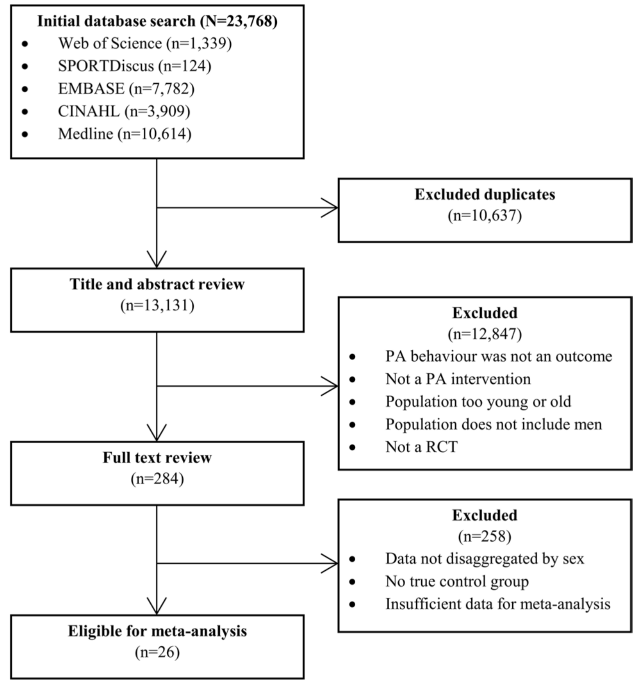

Figure 1 Pathway of articles identified and excluded. PA, physical activity; RCT, randomised controlled trial.

Moderator analyses were conducted to explore potential variations in effectiveness due to differences in study, participant or interventions characteristics, using mixed effects analysis. Subgroup analyses were used to explore heterogeneity and make comparisons between characteristics. Categories were determined based on previous literature as well as the cut points that may be relevant for future intervention design.[41] A common among-study variance was assumed across subgroups and a pooled within-group estimate of T^2 was used. In light of previous research exploring the effects of physical activity interventions[42] as well as work done in the field of men's health,[15 16 19] it can be reasonably argued that more intensive interventions (eg, greater contact frequency, using more types of behaviour change techniques) and interventions designed specifically for the target population (eg, gender-tailored) will be more effective. However, because previous research has provided a limited foundation for confirmatory hypothesis testing, the moderator analyses were considered exploratory and intended to be hypothesis-generating. Moderator analyses were not conducted for long-term physical activity change as only 12 studies included an additional follow-up 12 months or greater postintervention.

RESULTS

Description of included studies

The initial search strategy (excluding duplicates) identified 13 131 potentially relevant articles. Following title/abstract screening, 284 references remained from which an additional 258 articles were further removed following a full text review. Ultimately, 26 peer-reviewed journal articles (figure 1), representing 24 studies and independent samples,[43–68] were included in the review.

Tables 1 and 2 outline study design and intervention characteristics, respectively. Online supplementary table S3 provides an overview of the included interventions and additional details

Table 1 Study design and participant characteristics

	Study				Participant		
Primary source	Location	Design	PA measure	PA outcome*	N†	Mean age† (years)	Health status
Aguiar *et al*, 2016[43]	Australia	RCT	Obj	Secondary	101	52	Overweight
Andersen *et al*, 2012[43 45]	Norway	RCT	Obj	Primary	150	37	Inactive
Ashton *et al*, 2017[46]	Australia	RCT	Obj	Primary	50	22	Inactive
Galvão *et al*, 2017[47]	Australia	RCT	Sub	Primary	463	64	Cancer
Gong *et al*, 2015[48]	China	Cluster	Sub	Secondary	450	64	Hypertension
Gray *et al*, 2013[49]	Scotland	RCT	Sub	Secondary	103	47	Overweight
Groeneveld *et al*, 2011[50]	Netherlands	RCT	Sub	Not clear	816	47	General
Hunt *et al*, 2014[51]	Scotland	RCT	Sub	Secondary	747	47	Overweight
Livingston *et al*, 2015[52 53]	Australia	Cluster	Sub	Primary	147	66	Cancer
Maruyama *et al*, 2010[54]	Japan	RCT	Obj	Primary	110	40	MetS
McGowan *et al*, 2013[55]	Canada	RCT	Sub	Primary	423	68	Cancer
Morgan *et al*, 2013[56]	Australia	RCT	Obj	Secondary	159	48	Overweight
Morgan *et al*, 2014[57]	Australia	RCT	Obj	Secondary	93	40	Overweight
Morgan *et al*, 2011a[58]	Australia	RCT	Obj	Secondary	53	41	Overweight
Morgan *et al*, 2011b[59]	Australia	RCT	Sub	Secondary	110	44	Overweight
Morgan *et al*, 2009[60]	Australia	RCT	Obj	Secondary	65	36	Overweight
Patrick *et al*, 2011[61]	USA	RCT	Sub	Secondary	441	44	Overweight
Petrella *et al*, 2017[62]	Canada	RCT	Obj	Secondary	80	49	Overweight
Pritchard *et al*, 1997[63]	Australia	RCT	Sub	Secondary	66	43	Overweight
Schröder *et al*, 2018[64]	Spain	RCT	Sub	Secondary	6059	65	Overweight, MetS
Shin *et al*, 2017[65]	Korea	RCT	Sub	Secondary	105	28	Overweight
Viester *et al*, 2018[66]	Netherlands	RCT	Sub	Secondary	314	47	General
Werkman *et al*, 2010[67]	Netherlands	Cluster	Sub	Secondary	413	60	General
Wyke *et al*, 2019[68]	Europe‡	RCT	Obj	Primary	1113	46	Overweight

*Primary outcome indicates whether authors identified change in physical activity as a primary or secondary outcome of the study.
†Value for total sample; includes women in mixed-sex studies (ie, Gong *et al*[48], 2015 (42% men), Werkman *et al*[67], 2010 (85% men)).
‡England, Norway, Netherlands and Portugal.
Cluster, cluster randomised trial; MetS, metabolic syndrome; Obj, objective; PA, physical activity; RCT, randomised controlled trial; Sub, subjective.

about the included studies. Articles were published between 1997 and 2019 including a total sample size of 12 040 men. Ethnicity of participants were reported in only seven studies, of which five were predominantly white (>70%). Interventions primarily targeted overweight individuals (number of effect sizes (k)=14) and lasted on average 20 weeks (range 4–52 weeks). Intervention design varied between studies and often included multiple components with the majority including an aspect of face-to-face contact (k=19), education (k=24; that is, increasing knowledge or understanding), training (k=20; that is, imparting skills) and enablement (k=20; that is, increasing means/reducing barriers to increase capability or opportunity). Overall study attrition was 15% (range 5%–30%).

Online supplementary table S4 displays the study quality assessment for all studies. Overall study quality was mostly moderate (k=20; 83%), primarily due to participant self-referral (selection bias) and an inability to blind participants due to the nature of behavioural interventions. Studies rated as strong (k=4; 17%) were able to account for these issues by recruiting participants through a comprehensive list of the population (eg, clinical registry), which may not be feasible in community-based research and making efforts to blind assessors to participants' group allocation. The overall quality of evidence, assessed using GRADE,[28 29] was determined to be high for physical activity change and moderate for long-term physical activity change suggesting that we are very confident and moderately confident, respectively, that the true effect lies close to that of the estimate of the effect. Although there were concerns relating to self-referral and an inability to blind participants in some studies, we did not downgrade the quality because we deemed the overall risk of bias to be very low. Long-term physical activity change was downgraded by one level for inconsistency based on considerable heterogeneity (I^2=80) and relatively wide variance of point estimates across studies.

Overall analysis—main findings

Intervention effects on physical activity are reported in figure 2. The estimated overall mean effect of physical activity interventions in men was small but significant (d=0.35; SE=0.05; 95% CI 0.26 to 0.45; p<0.001). The effect size is consistent with a mean difference of 97 min of total physical activity per week or 980 steps per day between intervention and control participants. Review of the homogeneity statistic revealed a significant heterogeneous distribution (Q_w=72.32, p<0.001; I^2=68.20). The one study removed procedure indicated that no individual study had a substantial impact on the overall effect size. Egger's regression test revealed that publication bias may be present (p<0.01). No studies were added during the Trim and Fill procedure. Fail-safe N revealed that at least 876 unidentified studies with a mean effect of zero would be needed before the overall effect would no longer be statistically significant (p>0.05).

Twelve studies[45 47 48 50 51 53 56 59 60 66–68] reported an additional follow-up measure at least 12 months postintervention (figure 3). The overall mean effect for long-term physical activity change was small but significant (d=0.32; SE=0.09; 95% CI 0.15 to

Table 2 Intervention characteristics

Primary source	Intervention: Delivery	Focus	Contact	Gender tailored	Duration (weeks)	Types of behaviour change techniques (num; type)
Aguiar *et al*, 2016[43]	F2F, On	Com	Once	Yes	24	3 (Ed,T,En)
Andersen *et al*, 2012[44 45]	F2F, Tel	PA	2–3/week	No	20	3 (Ed,T,En)
Ashton *et al*, 2017[46]	F2F, On	Com	Weekly	Yes	12	3 (Ed,T,En)
Galvão *et al*, 2017[47]	Tel	Com	Monthly	No	24	3 (Ed,Ev,En)
Gong *et al*, 2015[48]	F2F, Tel	PA	Weekly	No	6	3 (Ed,T,Ev)
Gray *et al*, 2013[49]	F2F	Com	Weekly	Yes	12	6 (Ed,I,T,Ev,M,En)
Groeneveld *et al*, 2011[50]	F2F, Tel	Com	Monthly	No	24	3 (Ed,T, En)
Hunt *et al*, 2014[51]	F2F	Com	Weekly	Yes	12	6 (Ed,I,T,Ev,M,En)
Livingston *et al*, 2015[52 53]	F2F	PA	Biweekly	No	12	2 (Ed,T)
Maruyama *et al*, 2010[54]	F2F, On, Tel	Com	Monthly	No	16	3 (Ed,T,En)
McGowan *et al*, 2013[55]	Tel, Mail	PA	Once	No	4	2 (Ed,T)
Morgan *et al*, 2013[56]	On, Mail	Com	Biweekly	Yes	12	3 (Ed,M,En)
Morgan *et al*, 2014[57]	F2F	Com	Biweekly	Yes	7	4 (Ed,T,Ev,En)
Morgan *et al*, 2011a[58]	F2F	Com	2–3/month	Yes	12	4 (Ed,T,Ev,En)
Morgan *et al*, 2011b[59]	F2F, On	Com	2–3/month	Yes	12	5 (Ed,I,T,Ev,En)
Morgan *et al*, 2009[60]	F2F, On	Com	2–3/month	Yes	12	3 (Ed,T,En)
Patrick *et al*, 2011[61]	On	Com	Other	Yes	48	4 (Ed,T,Ev,En)
Petrella *et al*, 2017[62]	F2F, On	Com	Weekly	Yes	12	5 (Ed,I,T,Ev,En)
Pritchard *et al*, 1997[63]	F2F	PA	Bimonthly	No	48	2 (Ed,T)
Schröder *et al*, 2018[64]	F2F, Tel	Com	3/month	No	52	3 (Ed,T,En)
Shin *et al*, 2017[65]	F2F, On	Com	Monthly	No	12	3 (Ed,I,En)
Viester *et al*, 2018[66]	F2F, Tel	Com	Bi/monthly	No	24	3 (Ed,T,En)
Werkman *et al*, 2010[67]	Mail, On	Com	Other	No	52	2 (Ed,En)
Wyke *et al*, 2019[68]	F2F	Com	Weekly	Yes	12	6 (Ed,I,T,Ev,M,En)

Com, combined (eg, PA and diet); Ed, education; En, enablement; Ev, environmental; F2F, face-to-face; I, incentivisation; M, modelling; num, number; On, online; PA, physical activity; T, training; Tel, telephone.

0.48; p<0.001) and had a significant heterogeneous distribution (Q_w=55.81, p<0.001; I^2=80.29). The one study removed procedure indicated that no individual study had a substantial impact on the overall effect size. Egger's regression test was non-significant (p>0.05). No studies were added during the Trim and Fill procedure and a Fail-safe N calculation indicated that 186 unidentified studies would be needed to nullify statistical significance (p>0.05).

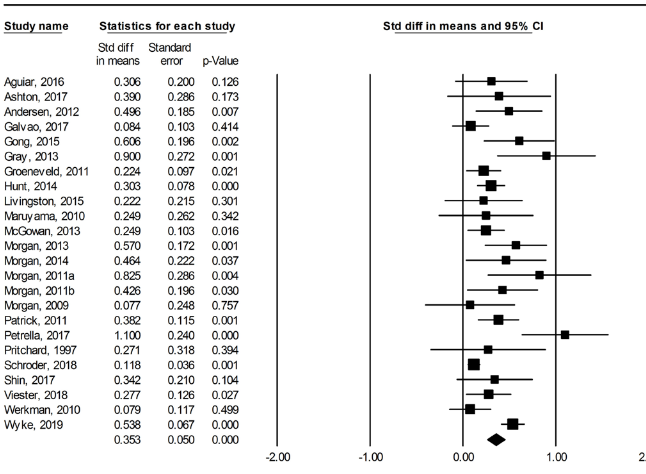

Figure 2 Forest plot of effect sizes representing effect on physical activity (baseline to postintervention).

Moderator analyses

Study characteristics

Mixed effects analysis produced significant between-moderator results for study characteristics on physical activity measurement, $Q_b(1)$ =9.30, p≤0.01. Studies that employed objective measures of physical activity were found to have a larger effect size (*d*=0.51; 95% CI 0.37 to 0.65) than studies that used subjective measures of physical activity (*d*=0.26; 95% CI 0.17 to 0.35). Table 3 provides details of the analyses for study characteristics.

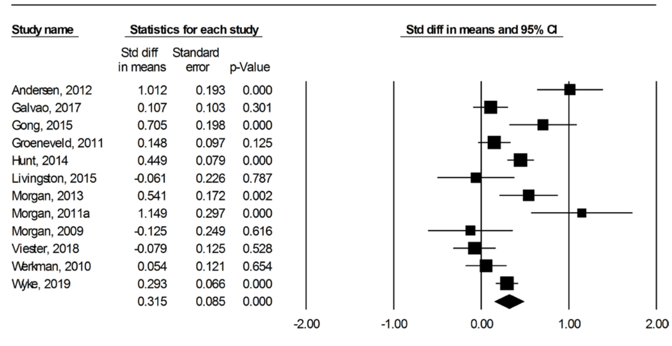

Figure 3 Forest plot of effect sizes representing effect on long-term (ie, ≥12 months) physical activity change.

Table 3 Physical activity interventions moderator analyses

	Effect size descriptive statistics					Null test	Heterogeneity statistics		
	k	*d*	SE	s^2	95% CI	Z	Q	T^2	I^2
Random effects model†	24	0.35	0.05	0.002	(0.26 to 0.45)	7.13***	72.32†	0.030	68.20
Study characteristics‡									
Study design							0.40		
RCT	21	0.37	0.05	0.003	(0.26 to 0.47)	6.80***		0.03	70.03
Cluster RCT	3	0.27	0.14	0.021	(-0.01 to 0.55)	1.87		0.05	62.55
Study quality							0.00		
Strong	4	0.36	0.13	0.002	(0.10 to 0.61)	2.75**		0.01	11.87
Moderate	20	0.35	0.05	0.003	(0.25 to 0.46)	6.51***		0.03	72.00
Measure							9.30**		
Subjective	14	0.26	0.05	0.002	(0.17 to 0.35)	5.66***		0.01	48.41
Objective	10	0.51	0.07	0.005	(0.37 to 0.65)	7.33***		0.01	29.81
PA outcome							0.33		
Primary	7	0.32	0.09	0.009	(0.14 to 0.50)	3.42***		0.03	63.97
Secondary	16	0.39	0.07	0.004	(0.26 to 0.51)	5.97***		0.04	68.91
Sample size							2.83		
n≤150	13	0.46	0.08	0.006	(0.30 to 0.61)	5.76***		0.02	29.30
n≥151	11	0.29	0.06	0.003	(0.18 to 0.41)	4.96***		0.03	77.89
Participant characteristics‡									
Mean age							0.20		
≤44 years	9	0.39	0.10	0.009	(0.20 to 0.58)	4.09***		0.00	0.00
≥45 years	15	0.34	0.06	0.003	(0.23 to 0.45)	5.88***		0.04	77.95
Population							0.78		
General	20	0.38	0.06	0.003	(0.27 to 0.49)	6.68***		0.04	71.28
Clinical	4	0.26	0.12	0.014	(0.03 to 0.49)	2.21*		0.02	47.50
Intervention characteristics‡									
Contact frequency							14.11***		
<1 weekly	14	0.22	0.05	0.002	(0.14 to 0.31)	4.98***		0.00	22.86
≥1 weekly	10	0.50	0.06	0.003	(0.39 to 0.62)	8.51***		0.02	47.60
Engagement							3.95		
High	3	0.68	0.17	0.028	(0.35 to 1.01)	4.04***		0.18	74.46
Moderate	10	0.34	0.07	0.010	(0.20 to 0.48)	4.79***		0.03	63.95
Low	6	0.31	0.10	0.005	(0.11 to 0.51)	3.04**		0.00	0.00
Gender-tailored							12.08***		
No	12	0.22	0.05	0.002	(0.12 to 0.31)	4.53***		0.00	21.27
Yes	12	0.47	0.06	0.003	(0.36 to 0.58)	8.55***		0.02	46.82
Duration							8.72**		
≤12 weeks	13	0.46	0.06	0.003	(0.35 to 0.57)	8.03***		0.03	53.08
≥13 weeks	11	0.23	0.05	0.003	(0.12 to 0.33)	4.26***		0.00	25.01
Theory							8.28**		
No	5	0.15	0.07	0.005	(0.01 to 0.30)	2.07*		0.00	0.01
Yes	19	0.40	0.05	0.002	(0.31 to 0.49)	8.84***		0.02	49.62
Behaviour change techniques							10.62***		
≤3 techniques	16	0.24	0.05	0.002	(0.15 to 0.34)	5.32***		0.01	26.98
≥4 techniques	8	0.51	0.07	0.004	(0.38 to 0.63)	7.72***		0.03	59.22

*P≤0.05, **P≤0.01, ***P≤0.001.
†Q_w value used to determine heterogeneity.
‡Q_b value used to determine significant differences between moderators.
d, effect size (Cohen's *d*); I^2, total variance explained by moderator(s); k, number of effect sizes; s^2, variance; SE, SE error; T^2, between study variance in random effects model; Z, test of the null hypothesis.

Intervention characteristics

Significant between-moderator results were present for contact frequency, $Q_b(1)$ =14.11, p≤0.001, gender tailoring, $Q_b(1)$ =12.08, p≤0.001, duration, $Q_b(1)$ =8.72, p≤0.01, theory, $Q_b(1)$ =8.28, p≤0.01 and number of types of behaviour change techniques, $Q_b(1)$ =10.62, p≤0.001). Interventions that had between one or more weekly contacts produced a larger effect size (*d*=0.50; 95% CI 0.39 to 0.62) than interventions that had less than 1 weekly contact (*d*=0.22; 95% CI 0.14 to 0.31). Interventions identified as gender-tailored had a larger effect size (*d*=0.47; 95% CI 0.36 to 0.58) than studies that were not gender-tailored (*d*=0.22; 95% CI 0.12 to 0.31). Those that were 12 weeks or less in duration produced a larger effect size (*d*=0.46; 95% CI 0.35 to 0.57) than interventions lasting 13 weeks or longer (d=0.23; 95% CI 0.12 to 0.33). Interventions that identified one or more theory used the guide intervention design produced a larger effect size (d=0.40; 95% CI 0.31 to 0.49) than interventions that did not use theory (d=0.15; 95% CI 0.01 to 0.30). Interventions that used four or more types of behaviour change techniques had larger effect sizes (d=0.51; 95% CI 0.38 to 0.63) than those that used three or less types of behaviour change techniques (d=0.24, 95% CI 0.15 to 0.34). All moderators had low between-study variance (T^2) and explained moderate to large portions of subgroup variance (I^2). Table 3 provides details of the analyses for intervention characteristics.

DISCUSSION

This paper reports on the first meta-analysis of RCTs to synthesise the effects of behaviour change interventions to increase men's physical activity, sustained physical activity change (at 12 months) and to identify variations in outcomes due to potential moderating variables. Overall, interventions had a small but significant effect on increasing physical activity levels (d=0.35) as well as postintervention sustainability of changes in physical activity (d=0.32). The effect size is consistent with an increase of approximately 97 min of total physical activity per week or 980 steps per day between intervention and control participants. These effect sizes are larger than a meta-analysis investigating the effect of physical activity interventions for healthy adults (d=0.19; 358 studies, 99 011 participants); however, the samples in that review were predominantly (74%) women.[2] Similar meta-analyses of interventions to promote physical activity among sedentary adults (d=0.31; 11 studies; 3940 participants; 44% men)[12] and chronically ill (eg, hypertension, cancer, diabetes) adults (d=0.45; 163 studies, 22 527 participants, 50% men)[1] are more in line with the present findings.

The role of physical activity in men's health promotion

Our finding suggests that physical activity may be an important point-of-entry to encourage men's participation in behaviour change. As Connell[69] suggested, 'masculinity' is associated with action and doing, and physical activity clearly qualifies as an acceptable outlet and performance opportunity for men. Men are motivated to engage in activities which are perceived to be more 'masculine', such as sport and physical activity, as they may be associated with strength, friendly competition and mastery.[70] Particularly when the aim is to improve health, including a focus on physical activity may be more appealing and acceptable to men than providing support for 'dieting' or dietary modifications alone, as demonstrated in evidence from the UK and elsewhere.[70–72] Notably, a majority of the identified interventions in the present analysis had a primary focus on other health behaviours (eg, weight loss) but used physical activity as an adjunct intervention strategy. Further, many of the studies (k=19; 79%) combined physical activity and other health behaviours (eg, diet), revealing opportunities for layering behaviour changes, in relative and relational ways that may engage and sustain men's participation. In this regard, physical activity may be viewed as a gateway that garners masculine capital, through which men may become more willing to address other health behaviours.[20 73]

Participant characteristics and subpopulations

Participant characteristics within the included studies highlight some important trends and areas for future research. Although the target audience for many of the interventions reviewed here were overweight men, there are also likely to be gains in tailoring physical activity programmes for other subgroups of men including those experiencing chronic illness. For example, prescription physical activity[74] and recreational football[75] have proven to be strong draws for men living with prostate cancer, as they have for weight loss[51] and physical activity interventions.[68] Resistance training has also been noted as a preferred modality of physical activity among men due to its perceived 'masculine' nature associated with strength but most importantly because it targets disease-related risk factors for men (ie, bone loss for men on androgen deprivation therapy).[76] Further, few studies provided sufficient detail of participants' sociocultural background, illuminating the need to formally evaluate the fit of men's physical activity health promotion programmes for marginalised subgroups. Men's health inequities, for example, may limit the access and involvement of subgroups including Indigenous men, those from culturally and linguistically diverse communities and men with low socioeconomic status. These subpopulations may benefit from culturally sensitive approaches to physical activity, with programmes designed to reduce structural barriers and address the resource-poor realities of these underserved end-users. It is especially poignant within these contexts that sustained programing, inclusive of longitudinal evaluations, are completed to ensure sustainability of the changes that are often initially garnered and gained immediately postintervention.

Implications for intervention design

Our findings indicate that a variety of programme designs and approaches hold potential for positively influencing men's physical activity. For instance, using multiple appropriate behaviour change techniques and increased contact with participants (ie, at least weekly throughout the programme) were associated with significantly larger physical activity effects, suggesting that intensive interventions (ie, greater intervention dose and frequency) may be more effective. While brief or limited contact interventions may be appealing as a cost-effective option, they limit opportunities for men to interact and connect with similar others. There is evidence to suggest that men are drawn to programmes where they can connect with men similar to themselves, in a 'male-friendly' environment and engage in friendly banter and competition.[20 72 77] That shorter interventions (12 weeks or less) were more effective than longer interventions may reflect that the majority of reviewed studies (k=11) were 12 weeks in duration. Although very brief interventions can produce acute changes in physical activity,[78 79] sustainable behaviour change likely requires some threshold of intervention intensity. Similarly, if the relative intervention intensity of longer duration interventions is too low, it may not be sufficient to elicit behaviour change. That most of these interventions ran for 12 weeks may bias or affirm that the optimal intervention duration for men lies somewhere in this range.

Although the majority of interventions in the included studies involved some type of face-to-face contact and multiple behaviour change techniques, it is noteworthy that interventions identified as gender-tailored were significantly more effective than those that were not (d=0.47 vs 0.22). This encouraging evidence adds to a small but growing body of research that indicates that the mode of programme delivery, as well as the content, is an integral factor in successful programmes aimed at increasing men's physical activity.[15 16] While offering men-only interventions is a gender-tailored intervention in itself, the novel and diverse modes of programme delivery represented in these interventions point to the need to be responsive to the needs and preferences of diverse groups of men to optimise intervention engagement and programme outcomes. Nevertheless, strategies used in the gender-tailored interventions reflect themes identified in successful efforts to promote men's health described by others and provide a useful direction for continuing efforts to promote men's health.[18 19 80] For example, gender-related strategies found to engage and retain men include the use of male-oriented language (eg, simple, straightforward messages/communications), images, humour and positive 'banter'; action oriented, strength-based approaches including realistic and manageable recommendations and providing men with flexible options that promote autonomy, self-reliance and mastery.

Interventions that were assessed using objective measures of physical activity were significantly more effective than interventions using subjective (self-report) measures. Self-reported behaviour has been observed to be both higher and lower than objective measures of physical activity.[81] Factors shown to predict discordances between measures include demographic characteristics such as education status[82] as well as differences in perceptions of what constitutes moderate or vigorous activity across demographic subgroups.[83] Interpreting subjective measures can be challenging.[84 85] For example, an intervention may affect how accurately an individual perceives and reports their physical activity and sedentary behaviour.[84]

Sustaining long-term physical activity change

Though additional research is needed regarding long-term physical activity change, it is promising that the 12 of 24 studies that included a long-term (ie, ≥12 months) follow-up measure had a small intervention effect (d=0.32). One study in the present analysis targeted overweight inactive male football fans and reported evidence of long-term behaviour maintenance of participants at 3.5-year follow-up.[86] These longitudinal findings of 213 men suggested that physical activity was significantly higher at 3.5 years than at baseline. This large-scale trial has informed the development of several subsequent gender-tailored interventions that also now include long-term follow-up in order to assess sustainability of physical activity change. For example, EuroFit,[68] which was delivered in four European countries, engaging 1113 men, includes a long-term follow-up of 12 months. Researchers must continue to evaluate the extent to which changes are sustained following intervention completion and consider strategies to promote long-term behaviour change.

Strengths and limitations

We report two study strengths and three limitations. This meta-analysis is the first to examine the effects of behaviour change interventions in men and it builds on previous research identifying effective intervention strategies for engaging and retaining male participants. In addition, all 24 included studies had a randomised design, thus minimising bias.

The considerable heterogeneity across the studies, including the target population, the ways in which studies targeted men as participants, and the various modes of intervention delivery represent a limitation. We included both clinical (eg, patients with cancer) and healthy populations which may be viewed as a limitation even though physical activity has been effective in the setting of several different chronic illnesses[1] and healthy populations.

With regard to the assessment of study quality, we acknowledge that there is often poor agreement between tools and that tools may measure different constructs of study quality.[25] The EPHPP is the recommended tool for assessing the quality of public health and health promotion studies. Despite this, challenges with assessing community-based trials remain as the majority of studies were rated down for participant self-referral and a lack of participant blinding. For almost any real-world behavioural intervention, a degree of volition and motivation to attend is required, both overall and session-by-session. Further, usually it is not possible to blind participants, or those delivering or assessing the intervention to group allocation, in these type of interventions (ie, participants know they are exercising). Considered collectively, these assessment tools include assumptions which favour a biomedical approach in which internal validity, as an outcome of tightly controlled trials, is prioritised over external validity and thus raises challenges for real-world implementation.[87] What is not reflected within such assessment is the value of pragmatic trials in implementing behaviour change within the environments in which they will be used.[87 88]

We also acknowledge that potentially relevant studies conducted on mixed-sex samples were not included because they failed to disaggregate their findings by sex—despite calls for the need to do so.[9] Thus, the majority of studies included had male participants only.

CONCLUSION

This meta-analysis suggests that men can make small, but potentially important, changes in their physical activity. Specifically, gender-tailored interventions, which include a core focus on physical activity, may help attract, engage and retain men to health behaviour interventions. This includes those with a primary focus on other behaviours, which is important for the improvement of individual and public health, in addition to physical activity. Scope clearly exists for researchers to better understand what types of interventions work for different men and why. Sustained improvement in physical activity is a public health holy grail and our study captures the current knowledge about men in that domain.

What is already known

- Men are under-represented in health promotion programmes.
- Physical activity has been identified as a draw facilitating men's engagement with health promotion initiatives and programmes and/or injury and illness management.
- Growing interest in men's health promotion has led to the development of interventions which include a focus on physical activity.
- Two systematic reviews have been conducted on physical activity interventions in men; yet the effects of randomised controlled trial (RCT) physical activity interventions are poorly understood.

What are the new findings

- Behaviour change interventions have a small but significant positive effect on men's physical activity.
- Interventions that (i) are based on a theoretical framework, (ii) are tailored to men's values and interests, (iii) include regular group contact and (iv) employ multiple behaviour change strategies appear most effective.
- There is some evidence that physical activity is sustained at long-term follow-up but more longitudinal research is needed.

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Contributors PS, JCS, JLB, JLO, KH, MVD and CMC helped conceive the project and PS and JCS were responsible for project management. PS, MVD and CMC

determined the search strategy and oversaw the screening of articles. PS and JCS were responsible for data extraction, analysis and interpretation. PS and CMC undertook quality assessment. All authors participated in the study design, drafting of the manuscript and critical revisions. All authors read and approved the final manuscript.

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