

A systematic review of the effects of remote feedback in home-based strategy physical activity interventions for cancer survivors

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Abstract

Background: Studies have reported on positive health outcomes from physical activity (PA) for cancer survivorship. Systematic reviews, meta-analysis and trial studies have concluded that PA intervention improves quality of life and physical function, reduces the relapse of cancer and mitigates cancer mortality. Despite these important gains, cancer survivors' PA level is still not satisfactory. Across all cancer types, home is the most preferred location of PA. This study aims to evaluate the effectiveness of remote feedback delivery strategy for home-based PA among cancer survivors.

Methods: A systematic review was conducted by retrieving relevant articles published from the year 2009 to 2019 from the database aggregator EBSCOhost (databases used were Medline, CINAHL, SPORT Discuss and Cochrane trials).

Results: Both frequent remote contact and direct remote contact are equally effective and have a larger effect than programmes with usual care, no intervention, participants placed in waiting list for intervention or participants given basic guidelines on PA. Direct remote contact reported strong evidence of moderate effect while frequent telephone contact reported conflicting findings of varied effect sizes.

Conclusion: Opting for remote feedback strategies with supervised exercise provide an easier approach for the cancer survivors to keep up with exercise for a longer period of time and can be integrated in a cancer survivor's lifestyle.

Background

Cancer is a growing public health concern worldwide. According to a World Health Organization (WHO) report in 2018, cancer is the second leading cause of mortality globally which accounted for 9.6 million deaths [1]. The incidence of cancer has also risen to 18.1 million new cases in 2018 [2]. It is estimated that one in every five men and one in every six women will develop cancer during their lifetime and the five years survival rate is estimated to rise to 43.8 million globally [1, 2]. Studies have reported on positive health outcomes of PA for cancer survivorship. Systematic reviews, meta-analysis and trial studies have concluded that PA intervention improves quality of life [3] and physical function [4], reduces the relapse of cancer and mitigates cancer mortality [5].

Despite these important gains, cancer survivors' PA level is still not satisfactory and is expected to decline by at least one third following diagnosis, by half post treatment and most of the time do not improve during several years post treatment [6]. As a matter of fact, a research has reported that only 29.5% of cancer survivors adhered to the American Cancer Society's guidelines of 150 minutes of moderate intensity exercise per week [7]. In Malaysia, only 23.5% of breast cancer survivors met the recommended PA level [8]. Another study of population based cohort in Australia in 2015 involving 463 prostate cancer survivors reported that only 12.3% did sufficient exercise levels, defined to be 150 min of moderate intensity or 75 minutes of strenuous intensity [9].

Across all cancer types, home-based PA or PA that is performed at the owner's home or living space was the most preferred location of PA as reported in a systematic review that includes 31 quantitative studies and three qualitative studies [10]. Cancer survivors find that home-based PA is convenient and flexible which is suitable for their busy schedule involving medical appointments, work and family commitment. In addition, it also removes the barrier of transportation, and make it easier for cancer survivors to integrate PA in their daily activities. In conducting an intervention that involve behavioural change, a theory-based intervention has shown impact in getting the acquired result. The same goes to home-based PA where according to the Social Cognitive Theory, an important factor for encouraging a behaviour is by getting feedback and encouragement. This can be done in the form of face-to-face counselling with a trainer but pose a challenge to home-based PA [11, 12]. Therefore, providing a remote-feedback PA, which has a similar function to a live supervision, would be useful for interventional studies that aim to enhance PA among cancer survivors. Remote feedback is defined as any physical contact or meeting between a fitness trainer with a participant aiming to improve effectiveness or adherence to a PA programme [12]. Remote feedback delivery strategies can be classified into three broad categories which are frequent telephone contact, non-frequent telephone contact and direct remote contact [12].

This study aims to evaluate the existing literature on the effectiveness of remote feedback delivery strategy for home-based PA among cancer survivors. An examination of the evidence on this type of delivery strategy for cancer survivor enables better planning of PA intervention programme for this group of population. Home-based PA that integrates a properly designed remote feedback would effectuate the initiation and adherence of PA. Concurrently, when an appropriate remote method of supervising PA is chosen, a less cost-intensive, less time-consuming, less privacy-invading and more accessible programme can be offered as compared to supervised exercising.

Methods

Identification of the studies

Relevant articles were identified by using EBSCOHost that retrieved articles from databases of CINAHL, Medline, SPORTDiscuss and Cochrane trials. The literature search was limited to articles published between 2009 and 2019. The principal search strategy was developed by Geraedts, Zijlstra, Bulstra, Stevens, & Zijlstra (2013) and was based on systematic reviews of the effectiveness of remote feedback delivery strategies in home-based PA among older adults [12]. The following search strategy and key terms were used tailored for this study objective:

1. Key terms #1: "homebased" OR home OR "home-based"
2. Key terms #2: remote OR stimulation OR coaching OR feedback
3. Key terms #3: monitoring OR telemonitoring OR telecommunication OR tele-communication OR telephone (NOT "telephone survey" OR "telephone surveys") OR physiotherapy OR "physical therapy" OR telerehabilitation OR tele-rehabilitation OR rehabilitation OR tele-exercise OR telecare OR tele-care OR teletraining OR teletraining OR telemedicine OR tele-medicine
4. Key terms #4: fitness OR balance OR mobility OR exercise OR "physical activity" OR activity OR "physical fitness" OR exercise OR "motor activity" OR "psychomotor performance" OR "exercise movement techniques" OR "postural balance"
5. Key terms #5: neoplasm OR cancer* OR "cancer survivor*" OR "cancer patient*"
6. Combination of key terms #2 or #3 (key terms 6): #2 OR #3
7. Combination key terms #1, #4, #5 and #6: #1 AND #4 AND #5 AND #6

Eligibility criteria

Following the databases searched, duplicates were removed and the remaining references were screened based on their title and abstract by the first author (MO) independently. Subsequently, the remaining articles were checked for relevancy on the research question. Any discrepancies in the selection of the articles were solved by consultation with the second author (NAMZ).

The following general inclusion criteria were formulated for the current study selection:

- (1) The study assesses PA intervention programmes that used remote feedback in the home It is defined as any PA interventions which does not include physical contact or meeting except for effect measurements and explanation of or initiation into the program, aimed at enhancing their PA.
- (2) The study design is a randomized controlled trial study
- (3) One of its outcome measurements is general PA behavior or physical capacity
- (4) The study participants are among cancer survivors

(5) Study with full text available and published

(6) The article is written in English.

In this review, adherence was also analysed in studies that addressed adherence along with the eligibility criteria. Adherence is defined as “the extent to which a person follows a prescribed exercise routine”[12].

Quality assessment

Quality assessment was conducted by using the PEDRO scale. For more information about the quality ratings see Additional 1. A total of 11 items with a dichotomous answer of “yes’ or “no” (1 and 0 points respectively) are being assess in the scale. Item 1 assesses for external validity or the eligibility criteria. Item 2 to 11 focus on the internal and statistical validity of the article. Quality assessment was performed independently by the researcher (MO), and any uncertainties were solved by the second researcher (NAMZ). A score of above 5 from the cumulative of item 2 to 11 was considered adequate trial quality and above 6 is considered high quality [13,14]. Only studies above than score 5 from the cumulative of item 2 to 11 will be included in the review. Five levels of evidence were classified from the quality assessment results as described below:

1. Strong evidence: generally $\geq 75\%$ of the studies reported consistent findings from multiple high rated quality studies.
2. Moderate evidence: generally $\geq 75\%$ of the studies reported consistent findings in one high quality study and one or more low-quality studies, or generally consistent findings in multiple low-quality studies.
3. Limited evidence: only one study in one high- or low-quality.
4. Conflicting evidence: $< 75\%$ of studies reported consistent findings
5. No evidence: no randomized controlled trials (RCTs) or non-RCTs.

Data analysis

Data extraction was performed from the included articles to perform the effectiveness analysis. Each outcome from the studies was calculated by using the standard mean difference (SMD) with a corresponding 95% confidence interval. The formula used for standard mean difference (SMD) is described below:

$$\text{SMD}, \theta = \frac{\mu_1 - \mu_2}{\sigma}$$

Standard mean difference formula

Following that, the values were interpreted as either a small effect (0.2–0.4), moderate effect (0.5–0.7) or large effect (0.8) [13]. Data summarization was performed using a qualitative best-evidence synthesis [14].

Results

Description of studies

The full study selection following PRISMA flow 2009 diagram is shown in Figure 1. Records identified using the database search from EBSCOHOST of MEDLINE, CINAHL, SPORT Discuss and Cochrane trials were 413 articles. After removing duplicates, the number of articles that remained were 350. Following the screening process based on title and abstracts, 32 articles were included. The final number articles included was 9 after removing those that were not experimental studies

(n=10), had no protocol development (n=6), did not involve remote feedback for PA (n=5), did not report PA outcome measures (n=1) and was a non-randomized controlled trial study (n=1).

Types of analyses

Six studies reported both effectiveness and adherence analysis [15–22] while three studies did not report any adherence analysis [23–25]. Apart from the outcome measurements is PA level or PA capacity, there is heterogeneity of the secondary outcome or other outcome measures in the included studies as shown in Table 1.

Description of study samples

The range of the sample sizes was between 17 and 410 and the range of participant age was between 31 years and 68 years. The overall mean age of participants in all included studies was 53.8 years. The types of cancer group included in the studies were varied. However, breast cancer and colorectal cancer (CRC) were among the cancer groups most frequently studied. Two studies focussed on young adult cancer [18,19,23] and CRC [20,25] and one study each on breast cancer [24], hematologic cancer [16,17], combination of breast cancer and CRC [21], combination of breast, prostate and CRC [22] and all types of cancer [15] (Table 1).

Quality of studies

Some studies lacked information to indicate randomisation, allocation concealment, blinding, and ancillary analysis. According to the PEDro scores calculated, there were three moderate quality studies [23–25] and six high quality studies [15–22]. None of these studies were rated as poor quality (Table 1). The range of PEDro scores from the included studies were between

6 and 9 of a maximum score of 11. The mean of the total score of the quality of all included studies was 7. In subanalysis, scores range for internal validity was between 5 and 8 (maximum score 10) with a mean score of 6. For more information about the quality ratings see Supplement 1.

Effectiveness of remote feedback strategies

Details on the effectiveness of remote feedback strategies are described in Table 1. The remote feedback strategies in the included studies were varied. Therefore, the remote feedback strategies were classified into 3 categories (direct remote contact, frequent telephone contact and non-frequent telephone contact) [12] as described below:

- (1) Frequent telephone contact: more than one phone call per month,
- (2) Non-frequent telephone contact: less than one phone call per month and
- (3) Direct remote contact: studies using direct remote strategies during PA other than telephone contact

Frequent telephone contact

The frequent telephone contact category has six studies with three studies [23–25] rated as moderate quality and three studies [16,17,20,21] rated as high quality. Effect size was unable to be calculated for three of the studies. Findings in the remaining three studies with measurable effect size showed conflicting evidence as less than 75% of them reported inconsistent findings in the PA outcomes. Two of the moderate quality studies reported improvement in both intervention group (IG) and control

group (CG) for PA outcome. Three of the studies were able to calculate for standard mean difference [16,17,20,21]. The effect size of those three studies ranged between 0.42 to 1.27 resulting in the average effect size of 0.75. Each of the studies with measurable effect size was classified as low effect [21], moderate effect [20] and strong effect [16,17]. These findings illustrate that frequent telephone contact showed a comparable or significantly better results on PA measures for the IG compared to the CG.

Direct remote contact

The three studies that remotely contacted participants directly were rated as high-quality studies [15,18,19,22]. Strong evidence of moderate effect size were in two of the high quality studies. All studies were able to calculate for standard mean difference with the effect size range of between 0.13 and 0.76, resulting in the average effect size of 0.49 or moderate effect. These findings illustrated that frequent direct contact showed a comparable or significantly better results on PA measures between the IG and the CG.

Adherence in remote feedback strategies

An overview of the adherence results in remote feedback strategies is described in Table 1. Four of the included interventions reported adherence results [18–22]. The adherence in IG varied widely from 16.4% [20] to 90% [21]. Two of the six interventions from frequent telephone contact provided adherence results, while two of the three interventions from direct remote contact provided sufficient information in the articles for adherence analysis.

Discussion

This systematic review presents an overview of literature pertaining to remote feedback delivery strategies in home-based PA interventions for cancer survivors. Geraedts et al., (2013) have conducted a similar systematic review but on a different study population which is older adults [12]. On top of effectiveness analysis, additional analysis was conducted here including adherence analysis. Both frequent telephone contact and direct remote contact were proven to have benefits at some extent in effectiveness but with varied strength of evidence.

Findings from this systematic review show that both frequent remote contact and direct remote contact are equally effective or has a larger effect than usual care, usual care, without any intervention, placed in waiting list for intervention or given basic guidelines on PA. Direct remote contact showed strong evidence of moderate effect size, while frequent telephone contact has shown conflicting evidence of varied effect size. However, the average effect size on each category favoured towards frequent telephone contact (0.79) as compared to the direct remote contact (0.49).

Studies using the frequent telephone contact strategy, most reported contact the participants once in a week with at least fortnightly contact and a few reported of biweekly contact with the participants. Frequent remote contact has a greater effect size value as compared to remote direct contact. However only three out of six studies using frequent remote contact provide available data of PA measures to determine the standard mean difference. For direct remote contact, all the three high rated quality studies calculated the standard mean difference and the effect size for PA measures could be determined. In addition, there is heterogeneity in the frequent telephone contact method in which two of the studies did integrate other strategies of remote feedback such as newsletters [24] and text messages [25]. Unfortunately, none of the aforementioned these studies were able to calculate for effect size. Furthermore, wide heterogeneity is seen particularly in studies using frequent telephone contact. The studies varied widely in terms of the target cancer groups, duration of

intervention and outcome measures. This heterogeneity is probably the cause of the conflicting results for effectiveness in the frequent contact group where some of the reported variables produced a mixed of negative and positive effect sizes although the overall effect size was large.

Meanwhile, for studies using direct remote contact, all the studies reported the variables that enabled the effect size to be calculated. It seems that direct remote contact is equally effective or has a larger effect than usual care or if there is no intervention consisting of PA measures. The strategies used for direct remote contact differ between each study. James et al. (2015) used pen-and-paper mailed [15], Valle et al. (2013) used a combination of Facebook and website [19] and Forbes, Blanchar, Mummer, & Courneya (2015) decided to employ a combination of websites and emails [22]. With the recent technology advancement where people can get connected everywhere and at any time, this shows that direct remote contact is a promising alternative to get in touch with participants remotely while monitoring their PA at home. Yet, more research is needed to look at various modes of direct remote contact to provide a strong evidence on its effectiveness.

Unfortunately, in this review none of the RCTs has been classified under non-frequent telephone contact. Therefore, comparison cannot be conducted between this method of remote feedback delivery strategy with either frequent telephone contact or direct remote contact.

More than half of the included articles that employ remote feedback strategies were developed based on specific theoretical frameworks. These consist of three studies that used frequent telephone contact [21, 23, 24] and two studies that used direct remote contact [15, 18, 19]. All of these studies are based on Social Cognitive Theory except for one study

used a combination of Social Cognitive Theory and Transtheoretical model [15]. Generally, theory-based interventions have shown a promising positive effect size when remote feedback strategies are used.

In this review, adherence results were extracted as part of the analysis. However, they were unsystematically inventoried in the studies. Adherence results for studies using frequent telephone contact have both the highest and lowest adherence findings. This illustrates the inconsistency of adhering to frequent telephone contact as a remote feedback delivery strategy. Based on the reported adherence information, consistent acceptable adherence to interventions using direct remote contact is seen in IG, varying between 43.7% and 58%. From these findings, direct remote contact for home-based exercise is determined to be a promising alternative to supervised onsite exercise. Although this review does not have any study categorised under non-frequent telephone contact, findings from a review of older persons using this method yielded a good adherence result [12]. However, it could not be concluded in this review as this type of remote feedback delivery strategy was not conducted among cancer survivors.

Finally, limitations in this review should be mentioned. Following the exact words used in the search strategy, studies that used remote feedback delivery strategies but were not using home-based or remote feedback were not included in the reference list. One of the selection criteria was that the studies must be reported in English language. Potential bias on language selection might limit findings from our articles. A few of the studies were also unable to provide sufficient data to allow us to calculate for standard mean difference particularly in the case of frequent telephone contact as a remote feedback delivery method. Therefore, the overall effect size might be not accurate for frequent telephone contact and the next method of best evidence synthesis is used since statistical evidence could not be provided.

Implications To Practice

Although in this review frequent telephone contact and direct remote contact gave favourable findings, researchers need to be cautious in employing such remote feedback strategies in their intervention programme. Frequent telephone contact might be cost intensive in a large scale intervention study while choosing an appropriate direct remote contact might be equally as effective as frequent telephone contact in addition to being less cost-intensive, less time-consuming and less privacy-invading as well as providing a wider sample coverage. Secondly, in a community-based or centre-based setting, direct remote contact coupled with a trainer can be an alternative for supervised exercising.

Conclusion

Overall, home-based exercise with remote feedback strategies provide additional benefits by simplifying the logistic aspect and can be integrated easily with a cancer survivor's lifestyle. However due to the various health condition of cancer survivors, supervised exercising in addition to remote feedback strategies provide a more effective approach for cancer survivors to keep up with exercise for a longer period of time and enjoy the associated health benefits.

Abbreviations

CG: control group; IG: intervention group; PA: physical activity; SMD: standard mean difference; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MO performed article review, data extraction and synthesis. NAMZ provided overview and consultation during the whole process. All authors contributed to writing the manuscript. All authors read and approved the final manuscript.

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Authors' information (optional)

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Tables

Table 1: Characteristics of included studies

Reference	Study design	Study size; mean age; cancer group	Characteristics of exercise programme	Feedback technology and frequency	Outcome measures	Results	^a E / A	Effect size	PEDro rating
(23)	RCT	N= 35 33.6 years Young adult post treatment cancer survivors	Duration: 12 weeks Intervention: Phone counselling with guided progressive PA of moderate-intensity PA toward a final goal of 30 min p/d on at least 5 days a week (i.e., between 55% and 69% of their maximum heart rate). Includes philosophy and practice of mindfulness meditation from a mindfulness CD Control: Waiting list	Weekly phone calls for 12 weeks then once every 3 months	1. PA level, fitness, POMS	Significant difference between groups in \geq moderate intensity PA p/w, reduction in treadmill walk test time. Significant improvement in POMS and fitness over time. No significant findings in accelerometer results.	E	Unable to calculate due to mean/SD not given	Moderate
(24)	RCT	N=45 58.5 years Breast cancer	Duration: 16 weeks Intervention: Home-based PA based on aerobic exercise, muscular strength, and flexibility training. Delivered via video, phone calls, newsletter and group session counselling Control: Waiting list	Biweekly phone calls and biweekly newsletters	1. Self-report PA level	Significant improvement of PA level over time in both IG and CG	E	Unable to calculate due to mean/SD not given	Moderate
(16,17)	RCT	N=51 52.6 \pm 13.7 years Hematologic cancer	Duration: 12 weeks Intervention: Phone counselling with progressive PA by at least 60 min p/w up to a maximum recommendation of 300 min p/w MVPA and	Weekly phone calls for 12 weeks	1. PA level 2. QoL 3. Fatigue	1. Significant difference between IG and CG for weekly aerobic exercise. QOL and fatigue not statistically significant	E	1.88; 1.5; 1.38,0; 0.94; 1.91 Overall ES= 1.52 (95% CI 1.03,2.02)	High

			received a copy of PA guideline. Control: To achieve at least 60 min p/w up to a maximum recommendation of 300 min p/w MVPA and received a copy of PA guideline.						
Reference	Study design	Study size; mean age; cancer group	Characteristics of exercise programme	Feedback technology and frequency	Outcome measures	Results	^a E / A	Effect size	PEDro rating
(20)	RCT	N=410 IG: 64.9 CG: 67.8 Colorectal cancer	Duration: 6 months Intervention: Telephone counselling, handbook, brochures and newsletter regarding behavioural counselling and to achieve at least 150 min p/w of MVPA Control: Received brochures	Phone calls biweekly for 5 months, followed by final telephone session 4 weeks later	1. 1O: PA level QoL, and fatigue 2.2O: BMI, dietary intake, alcohol intake and smoking	1.Adherence in IG 16.4%. 2.Significant increased in moderate PA/ vegetable intake, met Australian PA recommendations, reduced BMI/ total fat/ from saturated fat over time. No significant differences in HRQoL, cancer-related fatigue, fruit, fiber, or alcohol intake, or smoking over time	E+A	1.16; -0.21; 0.76 Overall ES= 0.57 (95% CI -1.18,2.32)	High
(21)	RCT	N= 121 IG: 53.1 years CG: 55.5 years Breast, colon or rectal cancer	Duration: 16 weeks Intervention: weekly exercise target was performance of at least 180 min of moderate-intensity PA and behavioural counselling based on SCT Control: Offered a telephone consultation with an exercise trainer after study completion	10-11 semi-structured phone calls over the 16-week intervention period	1. 1O: PA level, 2.2O: Physical functioning, fitness QoL, and fatigue	1.Adherence to daily steps pedometer was greater than 90% in IG 2. Significant increase in 6-min walk test distance and physical functioning in IG. PA level and other findings were non-significant	E+A	0.25; 0.58 Overall ES= 0.42 (95% CI -1.68,2.51)	High
(25)	RCT	N= 17 55±12.94 years Colon and rectal cancer	Duration: 12 weeks Intervention: Supervised group counselling for home-based PA with progressive PA level to 18 MET h p/w and increased to 27	Weekly phone counsel, routine daily text messages	1.1O: PA level 2.2O:Biomarkers	1. Significant increase in both IG and CG for PA level over time. No significant difference between groups. 2. Increase in PA showed significant reduction of	E	Unable to calculate due to mean/SD not given	Moderate

			MET h p/w with recommended brisk walking, hiking, stationary bike, or swimming. DVDs on PA also included Control: Written information on healthy lifestyle			insulin, HOMA-IR, TNF- α and significant increase in IGF-1, IGF binding protein and adiponectin over time			
(15)	RCT	N=133 56.2 years Post treatment cancer survivors	Duration: 8 weeks Intervention: Supervised a training group for home-based PA that included diet counselling. The time of PA was gradual lengthen between sessions Control: Waiting list	Pen-and-paper, mailed	1.10 pedometer-assessed step counts 2. 20: self-reported PA and resistance training, sitting time, dietary intake, weight, and BMI	1. Significant difference between groups for \geq steps counts over time. Significant intake of vegetables in both IG and CG. Significant increase in fruit and fibre consumption, decreased alcohol and fat consumption in both IG and CG. Significant reduction of weight and BMI in IG. No significant difference between groups in self-reported PA and waist circumference	E	1.12; 1.42; -0.65 Overall ES= 0.63 (95% CI -2.15,3.41)	High
Reference	Study design	Study size; mean age; cancer group	Characteristics of exercise programme	Feedback technology and frequency	Outcome measures	Results	^aE / A	Effect size	PEDro rating
(18,19)	RCT	N= 86 30.8 years Young adult post treatment cancer survivors	Duration: 12 weeks Intervention: Progressive MVPA levels to 150 min p/w with a focus on walking. Received behavioural counselling based on SCT through Facebook and website links Control: To achieve Progressive MVPA levels to 150 min p/w with a focus on walking. General	Online via Facebook and website	1. 10:PA level 2. 20: Weight, BMI, QoL	1. Adherence in IG 43.7% 2. Significant increase of MVPA and total PA in both IG and CG over time, however IG had greater improvement. Significant increase of light PA in IG. Significant weight loss and BMI in IG over time. No significant difference in QoL	E+A	0.12; 0.89; 0.76 Overall ES= 0.59 (95% CI -0.43,1.61)	High

			information of PA through Facebook messages with general exercise information and limited website links						
(22)	RCT	N=95 65.1±8.5 years Breast, prostate, colon and rectal cancer	Duration: 9 weeks Intervention: Behavioural counselling via website link to achieve vigorous PA of 75 min p/w, moderate PA of 150 min p/w, or a combination of both Control: Usual care	Website and weekly emails	1. PA level and QoL	1. Adherence of meeting aerobic guideline in IG 58% 2. Significant improvement in QoL in CG overtime. PA level showed no significant difference between group and overtime.	E+A	0.39; 0.31; 0.28; 0.18; -0.49 Overall ES= 0.13 (95% CI -0.31,0.58)	High

Legend: p/w=per week, min=minute(s), h=hour, PA=physical activity, IG=intervention group, CG=control group, QoL=quality of life, 1O=primary outcome, 2O=secondary outcome, MET= metabolic equivalence rate, MVPA= moderate-vigorous physical activity, POMS= Profile of Mood States, TNF=tumor necrosing factor, HOMA-IR= Homeostatic model assessment of insulin resistance, IGF=insulin-like growth factor, SCT= Social Cognitive Theory, overall ES= average ES

^aE: article included in effectiveness evaluation; A: article included in adherence evaluation

Figures

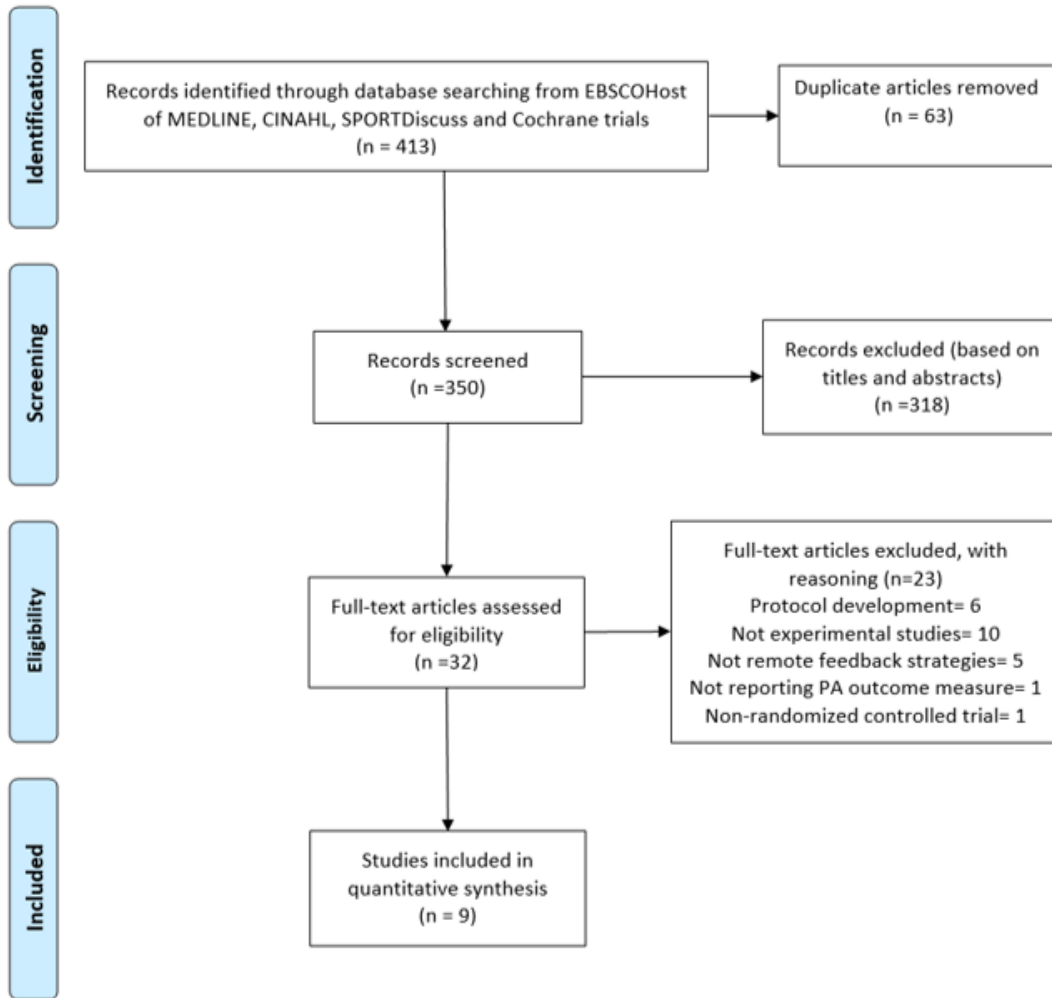


Figure 1

PRISMA flow diagram of full selection of articles

Supplementary Files

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- [Supplement1PO.docx](#)