Home-based interactive e-health educational intervention for middle-aged adults to improve total exercise, adherence rate, exercise efficacy, and outcome: a randomised controlled trial

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KEY MESSAGES

1. e-health educational intervention (e-HEI) significantly improved the amount of physical exercise in middle-aged adults in the first 3 months.
2. Although results favoured the intervention group with enhanced lipid control, exercise self-efficacy, and exercise adherence, the difference between the intervention and control groups was not significant.
3. Process evaluation revealed that the e-HEI could be implemented in clinical settings and accepted by participants to support their exercise maintenance, exercise, and health status.
4. Findings of this study may help healthcare professionals in strategic planning of e-HEI and continuous support to promote good exercise habits among Chinese patients with coronary heart disease.

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Introduction

In Hong Kong, >80% of patients with cardiovascular disease are diagnosed with coronary heart disease (CHD), and the incidence is increasing in middle-aged adults (age >40 years).[1] Preventive strategies (such as physical activities, healthy dietary choices, and quitting smoking) are effective approaches to reduce modifiable cardiovascular risk factors. Web-based and technology-supported programmes have contributed to the improvement in exercise adherence and outcomes.[2-5] These programmes are effective if delivered individually by telecommunication for support and an enhanced interactive approach. In view of the advantages of e-health programmes and the widespread use of the internet, as well as a growing number of young patients with CHD, an interactive e-health educational intervention (e-HEI) was developed.

Methods

We hypothesised that e-HEI programme participants would exhibit significant improvement in the amount of exercise taken, exercise self-efficacy, exercise adherence, and total exercise time. Participants would have improved control of their cardiovascular risk factors and health-related quality of life, and reduced anxiety and depression.

This prospective, multi-site, randomised controlled study used a two-group pre-test and repeated post-test, between-subject design, and process evaluation. Allocation sequence was computer-generated by a statistician who was blinded to investigators. A blocked randomisation method was used, with a block size of 4 (1:1). A small card indicating group assignment was placed in a sealed envelope, which was opened after patients completed the baseline questionnaires.

Chinese patients aged 30 to 65 years who attended regular follow-up for CHD-related problems and were able to access the Internet at home were recruited from the cardiac clinic of two regional hospitals in Hong Kong. Considering an effect size of 0.3 in our pilot study,[3] at least 438 patients were needed in each group to achieve a statistical power of 80% at 5% significance level, assuming a 20% attrition rate over the 6-month follow-up period.

Eligible patients were randomised to the control group to receive standard care or the intervention group to receive standard care plus e-HEI. The standard care comprised a routine doctor consultation, prescribed medication, and an educational leaflet.

The e-HEI website (http://ehealth.nur.cuhk.edu.hk) was based on the Health Belief Model. Patients in the intervention group received a 35-minute individualised educational intervention administered by a trained research assistant. The intervention aimed to teach the patients to use the

e-HEI website. Participants were advised to perform brisk walking or a usual exercise for 30 minutes per day, 5 days per week. The exercise amount was modified by the physician based on the individual's physical condition and agreed goals. Patients were followed up by telephone 1 week after the initial contact to facilitate use of the e-HEI system.

A sample of 24 patients from the intervention group were invited to attend a semi-structured in-depth interview. An interview guide was used, and contents were analysed.

The primary outcome was total physical exercise quantified by the modified Godin-Shephard Leisure-Time Physical Activity Questionnaire (GSLTPAQ). Patients were instructed to record the amount of exercise taken and rank the exercises in order of difficulty (strenuous, moderate, and mild). This approach has been widely used and shown to exhibit good psychometric properties. Secondary outcomes included (1) exercise efficacy (evaluated by the Chinese version of Self-Efficacy for Exercise) and adherence rate (determined as the total exercise time against the agreed goal [150 minutes per week]) and (2) physical and psychological health outcomes including levels of anxiety and depression (measured by the Hospital Anxiety and Depression Scale), health-related quality of life (measured by Short Form-12), and biological parameter outcomes such as body weight, body mass index, haemoglobin A1C, and risk factor profiles (systolic and diastolic blood pressure, total cholesterol, low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], and triglycerides).

Data were collected using a structured questionnaire from June 2013 to January 2015 by a trained research assistant who was blinded to group assignment. Patient demographics, and clinical and biological parameters were retrieved from medical

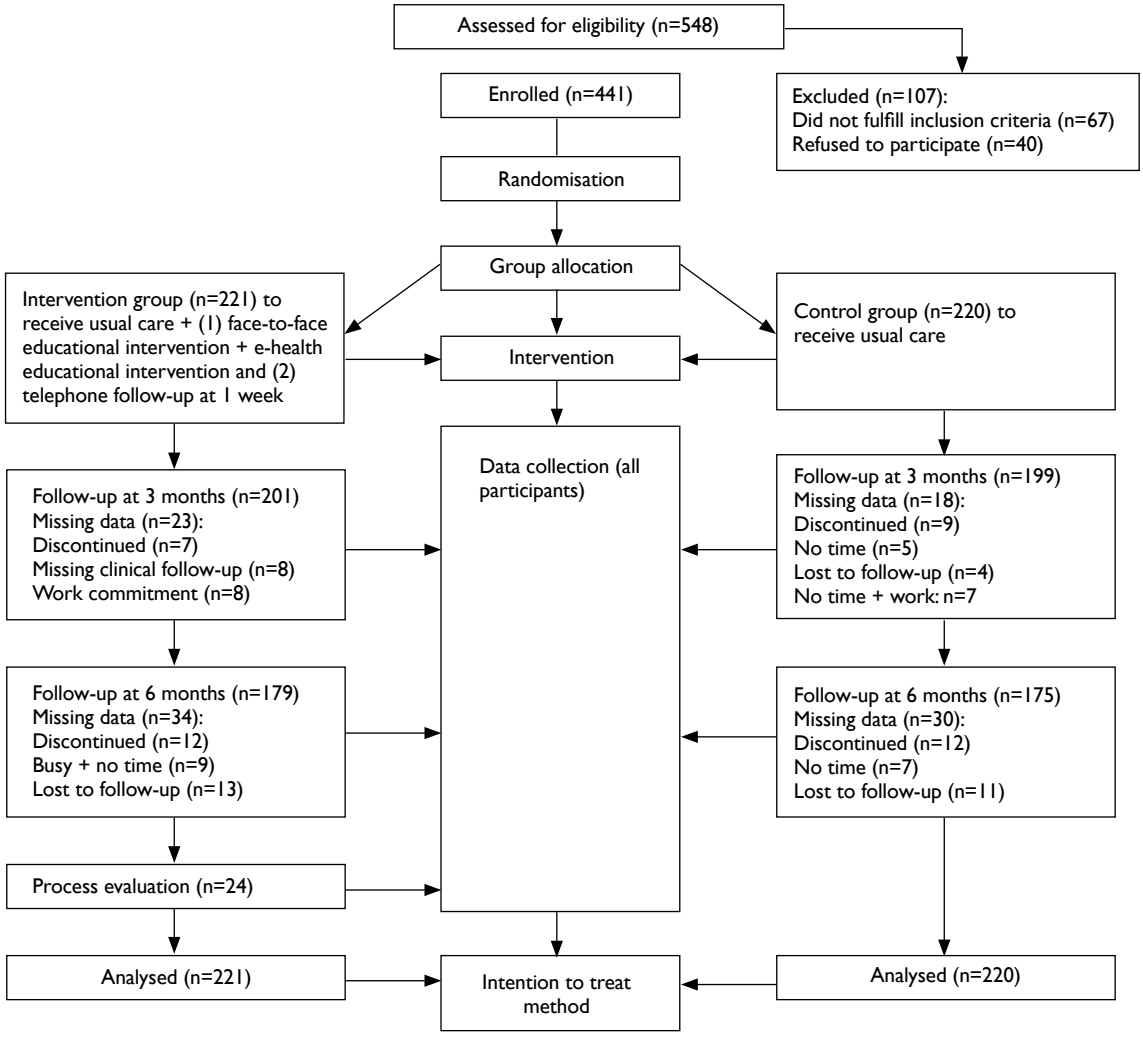

FIG. Flowchart of recruitment

TABLE 1. Clinical characteristics of participants*

Variable	Intervention (n=221)	Control (n=220)	P value
Age (years)	50.22±5.07	52.46±4.72	<0.001
Gender			
Male	150 (67.9)	141 (64.1)	0.402
Female	71 (32.1)	79 (35.9)	
Body mass index (kg/m^2)	26.20±4.38	25.63±3.80	0.150
Education			<0.001
Primary or below	9 (4.1)	50 (22.7)	
Secondary	146 (66.7)	151 (68.6)	
Tertiary	64 (29.2)	19 (8.6)	
Marital status			0.641
Married	172 (79.3)	168 (77.4)	
Not married	45 (20.7)	49 (22.6)	
Financial status			<0.001
Good	66 (30.4)	22 (10.2)	
Average	144 (66.4)	176 (81.5)	
Poor	7 (3.2)	18 (8.3)	
Residential status			0.330
Live alone	12 (5.6)	17 (8.0)	
Live with family	202 (94.4)	196 (92.0)	
Smoking			0.071
Yes	19 (8.6)	31 (14.1)	
No	201 (91.4)	189 (85.9)	
Employment status			<0.001
Working	190 (86.8)	158 (72.5)	
Not working	29 (13.2)	60 (27.5)	
Hospital Anxiety and Depression Scale-Anxiety			0.607
0 (score ≤7)	166 (75.8)	169 (77.9)	
1 (score ≥8)	53 (24.2)	48 (22.1)	
Hospital Anxiety and Depression Scale-Depression			0.342
0 (score ≤7)	177 (80.8)	165 (77.1)	
1 (score ≥8)	42 (19.2)	49 (22.9)	
Short Form-12			
Physical Component Summary	45.47 (6.79)	45.86 (7.25)	0.557
Mental Component Summary	48.11 (8.99)	48.27 (10.15)	0.857
Total exercise time per week	134.61±142.78	128.55±147.46	0.742
Godin-Shephard Leisure-Time Physical Activity Questionnaire score	16.85±11.72	15.74±14.48	0.283
Exercise self-efficacy	3.97 (1.95)	3.88 (2.27)	0.666

* Data are presented as No. (%) or mean±SD

records. The intention-to-treat principle and the generalised estimating equation model were used, with adjustment for confounding variables. Two consecutive follow-ups were conducted at 3 and 6 months (T2 and T3, respectively).

Results

The Figure shows the recruitment of participants. Table 1 shows the clinical and baseline characteristics for the intervention and control groups. The intervention group (n=221) and the control group (n=220) yielded an attrition rate of 9.3% and 14.5% at T2 and T3, respectively. Both groups were comparable in terms of clinical characteristics, except for age, educational level, financial status, and employment status. These were considered confounding variables.

Table 2 summarises the generalised estimating equation results for the different changes in the outcomes across the time points between the two groups, with adjusted confounding factors. The generalised estimating equation model can take account of the intra-correlated repeated measures data and can accommodate missing data due to incomplete visits or dropouts.

The total amount of exercise (GSLTPA score) over the 3-month period elicited a significant interaction effect (P=0.02). At 3 months, the intervention group had a significant increase in GSLTPA score compared with the control group (B=3.18, P=0.02) with a Cohen's d of 0.28. At 6 months, the increase was not significant (B=2.12, P=0.14) with a Cohen's d of 0.18. No significant main effect or between group and interaction effects were observed in the total exercise time per week.

80% adherence to exercise was regarded as good. In the intervention group, 36.2% (n=80), 43.4% (n=95), and 39.4% (n=87) of participants showed good adherence at T1, T2, and T3, respectively, compared with 37.7% (n=80), 37.7% (n=83), and 38.2% (n=84) in the control group. More participants in the intervention group showed satisfactory exercise adherence at T2 and T3, with a risk ratio of 1.15 at 3 months and 1.03 at 6 months. No significant main effect or between-group effects were found in exercise self-efficacy, although the intervention group performed slightly better (B=0.219 in T2 and B=0.012 in T3).

Regarding the Hospital Anxiety and Depression Scale, the interaction effect was non-significant across 6 months suggesting that the changes did not depend on the type of intervention. Nonetheless, there were a main effect for time across 6 months (P<0.05), a between-group effect in anxiety (P=0.004), and a main effect for time across 6 months for depression (P<0.05).

The main effect of time was significant at T3 (P<0.05) for the Physical Component Summary score and at T2 and T3 for the Mental Component Summary score, but the interaction effect and between group effects were not significant. Therefore, the changes in Physical and Mental Component Summary scores were independent of the type of intervention.

The biological parameters did not differ

TABLE 2. Generalised estimation equation model for comparison of repeated measure outcome variables between intervention and control groups

Variable	β	95% CI		P value	Cohen's *d*
Systolic blood pressure					
Group	-0.214	-3.36	2.93	0.89	
Month 3	-0.118	-2.41	2.18	0.92	
Month 6	-0.143	-2.27	1.98	0.89	
Group x month 3	0.358	-2.73	3.44	0.82	0.04
Group x month 6	1.369	-1.77	4.51	0.39	0.08
Diastolic blood pressure					
Group	1.766	-0.38	3.91	0.11	
Month 3	-0.480	-2.20	1.24	0.58	
Month 6	0.491	-0.89	1.87	0.49	
Group x month 3	-0.638	-2.87	1.60	0.58	-0.02
Group x month 6	0.075	-1.92	2.07	0.94	0.02
Total Exercise time per week					
Group	13.162	-11.20	38.24	0.30	
Month 3	7.736	-8.17	23.64	0.34	
Month 6	11.099	-7.54	29.74	0.24	
Group x month 3	3.47	-20.39	27.33	0.89	0.04
Group x month 6	-1.85	-28.85	25.13	0.78	<0.01
Total amount of exercise (Godin-Shephard Leisure-Time Physical Activity Questionnaire score)					
Group	1.363	-1.13	3.85	0.28	
Month 3	-0.988	-2.96	0.98	0.33	
Month 6	-0.917	-3.13	1.30	0.42	
Group x month 3	3.176	0.60	5.75	0.02	0.28
Group x month 6	2.119	-0.72	4.96	0.14	0.18
Self-Efficacy for Exercise					
Group	0.083	-0.32	0.49	0.69	
Month 3	0.244	-0.07	0.55	0.12	
Month 6	0.673	0.34	1.01	0.001	
Group x month 3	0.219	-0.16	0.60	0.26	0.11
Group x month 6	0.012	-0.42	0.44	0.96	-0.02
Anxiety					
Group	0.728	0.05	1.41	0.04	
Month 3	-0.428	-0.81	-0.45	0.03	
Month 6	-0.806	-1.22	-0.39	0.001	
Group x month 3	3.47	-20.39	27.33	0.89	-0.04
Group x month 6	-1.85	-28.85	25.13	0.78	0.05
Depression					
Group	-0.153	-0.79	0.48	0.64	
Month 3	-0.825	-1.27	-0.38	0.001	
Month 6	-1.272	-1.73	-0.81	0.001	
Group x month 3	0.124	-0.46	0.71	0.68	0.06
Group x month 6	0.570	-0.05	1.19	0.07	0.24
Physical Component Summary					
Group	-0.320	-1.65	1.02	0.64	
Month 3	0.826	-0.08	1.73	0.07	
Month 6	1.377	0.35	2.41	0.01	
Group x month 3	-0.160	-1.42	1.10	0.80	<0.01
Group x month 6	0.284	-1.15	1.72	0.70	0.02
Mental Component Summary					
Group	0.225	-1.50	1.95	0.80	
Month 3	2.056	0.64	3.47	0.004	
Month 6	2.990	1.51	4.47	0.001	
Group x month 3	-0.624	-2.35	1.10	0.49	-0.02
Group x month 6	-1.419	-3.27	0.44	0.13	-0.12

significantly, although the results favoured the intervention group in terms of lipid control (ie HDL-C level increased and LDL-C level decreased).

In process evaluation, the e-HEI could be applied in clinical settings and accepted by participants to support their exercise maintenance, exercise, and health status. Most participants had a positive perception of the e-HEI. As a consequence, regular exercise was performed at home. e-HEI was regarded as an additional professional support to maintain self-exercise behaviour. Peer dynamics, social support from family and work colleagues, and Chinese cultural influences on exercise behaviour may contribute to exercise maintenance.

Discussion

The e-HEI effectively promoted aerobic physical exercise such as brisk walking. The intervention group showed higher exercise self-efficacy and exercise adherence at 3 months. Exercise has a positive effect on promoting physical activity and enhancing body weight control and lipid profile after 12 months.[2,4,5] The active ingredient of the programme[4,5] may be counselling or supervised exercise. Our study relied on website information and exercise maintenance support; hence, the amount of physical exercise increased, and the main effect was significant within 3 months. Our intervention likely elicited positive effects on physical exercise up to 3 months. A sustainable longer effect (up to a year) or a stronger form of intervention should be explored in further studies.

The interaction effect on the Hospital Anxiety and Depression Scale did not differ significantly within 6 months. In terms of the Mental Component Summary score, mental well-being improved and a significant time effect was observed. In contrast, no significant differences between groups or interaction effects were observed. The Self-Efficacy for Exercise score increased to a greater extent at 3 months than at baseline. The intervention group improved in terms of self-efficacy measure, with great effect size within 3 months, but not within 12 months. Our findings suggest that the intervention effect might not be sufficient to achieve significance. Further reminder alerts via the web or other means, as well as advanced strategies should be implemented in the future development of the e-HEI to prevent the dilution effect.

Although the HDL-C and LDL-C levels of the intervention group were higher than those of the control group, this may have been due to medication control because all participants were followed up regularly and received appropriate medication.

The e-HEI could be applied to clinical settings and accepted by participants to support their exercise maintenance, exercise, and health status. Peer and family support further contributed to exercise maintenance and thus promoted exercise adherence and e-HEI.

Conclusion

E-HEI is a safe means to encourage exercise behaviour to improve the amount of physical exercise, Self-Efficacy for Exercise score, and adherence in the first 3 months, but its effects were not sustained in the long term. The qualitative findings of the process evaluation also confirmed the acceptability and need for an e-health programme as a professional means to support the self-management of exercise habits and health of patients with CHD.

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