Cost-effectiveness of a preventive self-care health management program for community-dwelling older adults: A randomized controlled trial

Abstract

Objectives: To examine the cost-effectiveness of a preventive self-care health management program for community-dwelling older adults as compared to usual care.

Design/ Intervention: A cost-effectiveness analysis was executed alongside a randomized controlled trial. Nurse case managers provided interventions, including holistic assessment, empowerment of self-care, preventive health behaviors and self-efficacy with co-produced care planning, supported by nursing students. The control group received social control calls.

Participants/ Setting: Community-dwelling older adults were randomly assigned to the intervention (n=271) or control (n=269) group. The intervention was conducted in collaboration with 11 community centers under four non-government organizations in various districts of Hong Kong.

Measurements: Cost and quality-adjusted life years (QALYs) were collected at pre- (baseline, 0 months) and post-intervention (3 months), and three months after completion of the program (6 months). Incremental cost-effectiveness ratios (ICER) between the groups were calculated, dividing the difference in cost by the difference in QALYs.

Results: Analysis showed that the net incremental quality-adjusted life years gain was 0.0014 (3 months) and 0.0033 (6 months) when the intervention group was compared to the control group.

The probability of being cost-effective at 6 months was 53.2% and 53.4%, based on the cost-effectiveness thresholds recommended by both the National Institute for Health and Clinical Excellence ($200,000/quality-adjusted life years) and the World Health Organization (Hong Kong gross domestic product/capita, HK$381,780).

Conclusions: The results provide some evidence to suggest that the addition of a home-based, preventive self-care health management program may have effects on cost outcomes for community-dwelling older adults in Hong Kong.

Keywords: self-care, cost-effectiveness, self-efficacy, community-dwelling older adults

Introduction

Many countries have placed considerable emphasis on programs that empower older adults to self-care or take control of their own health with the aim of promoting their independent living and reducing the demands they place on costly tertiary care services [1,2]. In general, these programs cover a wide range of interacting activities, such as nurse-led home visitation, health promotion and education, and case management and coordination. Evidence on the effects of health outcomes on these preventive programs is mixed. Though some studies reported non-positive outcomes [2,3], these preventive, integrated care programs were useful in improving physical and mental wellbeing and reducing depression and mortality rates for community-dwelling older adults [4,5]. Our current randomized control trial has also provided evidence that a nurse case management with self-care empowerment approach could produce positive health outcomes in regard to the improvement in self-efficacy, activity of daily living and quality of life among community-dwelling older adults [6]. The cost-effectiveness of these health maintenance programs is yet to be established however.

Previous studies have demonstrated cost-effectiveness of preventive, self-management program on frail older adults [7-9] and older adults who have a known underlying chronic illness such as hypertension [10] and chronic obstructive pulmonary disease [11]. However, existing economic evaluation does not provide a sufficient knowledge base for addressing merely the effects of preventive self-care health management program on older adults who are functioning well and living independently in the community. In reality, these relatively healthy older adults comprise more than 80% of the elderly in the community [12]. Literature indicated that these functionally independent older adults who have no acute illnesses often face health and social challenges,

such as difficulty in managing chronic conditions and poor knowledge of available community resources, which may lead to deterioration in their health condition and frequent use of health care services [13]. Given that these community-dwelling older adults require considerable healthcare expenditure potentially, there is a need for researchers and policy makers to identify intervention strategies that can enhance their well-being, prevent inappropriate use of healthcare services, and thus control healthcare costs [14].

Methods

Design

This study was a single-blinded, randomized controlled trial, details of which have been reported elsewhere [15]. Briefly, the study was conducted in collaboration with 11 community centers under four non-government organizations in Hong Kong.

The subject inclusion criteria were (1) being aged 60 or over, (2) living within the respective service areas, and (3) being cognitively competent (score ≥ 18) based on the Chinese version of the Mini-Mental Status Examination (C-MMSE) [16]. Exclusion criteria were (1) not able to communicate, (2) bedbound, (3) not able to be reached by phone, (4) not living at home, (5) having known active psychiatric problems and recent hospitalization within the previous 6 months, (6) being already engaged in structured health or social programs, and (7) not intending to stay in Hong Kong over the subsequent three months. Ethical approval was sought from the study university. Consent forms were signed by those subjects who met the criteria and agreed to participate in the study.

Intervention

The older adults in the intervention group received a preventive self-care health management program delivered by nurse case managers who were experienced in primary health care and trained specifically for this study. The aim of the intervention program was to engage and empower the community-dwelling older adults to take action on preventing diseases, maintaining and promoting health and functioning, and managing chronic illnesses and disabilities by assessing and resolving their health and social problems proactively, building up their self-care confidence, and providing referral services to other health care disciplines in the community. The Omaha system was adopted to assist nurse case managers in conducting the holistic assessment-intervention-evaluation in the first home visit. Home visits and telephone calls were employed to follow up on the caring goals set by the nurse case manager and older adults. The Omaha system has been validated and used in previous nurse-led self-care studies [17,18]. Appendix 1 shows the study flow of the program.

Older adults in the control group received monthly social control calls from another group of student helpers to exclude any possible social effects of the intervention. As in routine practices, they could voluntarily join the episodic, unstructured health and social services organized by their respective community centers. For details of the interventions, see the published protocol [15].

Study procedure and data collection

A three-month intervention program was introduced in this study, with the first month acting as a loading dose that involved weekly intervention contact. The second and third months were

considered as maintenance dose, with biweekly intervention contact. Cost and health outcomes were collected pre- (baseline, 0 months) and post-intervention (3 months) and three months after completion of the program (6 months) by research assistants who were not involved in the program.

Cost and health outcomes

The costing was estimated from the healthcare provider's perspective. The cost components included the pre-intervention training, the intervention cost for the service provider, and the health service cost related to medical consultation and hospital admissions. The pre-intervention training cost was the time cost for both the trainers and the trainees. It was calculated by multiplying the total time spent on training with the salary of the corresponding staff rank (Appendix 2). The median monthly salary of Hong Kong (2016 rate adjusted to 2018 level using CPI) was used to estimate the time cost for nursing students. The service provider cost for delivering the intervention included the staff time spent on home visits, telephone calls and documentation, as well as the equipment purchased for the study. Health service costs included all public and private health services the subjects used during the study period, i.e. between baseline and 6 months. They were calculated as the number of visits multiplied by the unit costs for each type of service based on the HA's latest public charges to non-eligible persons [19], i.e. GP visits (HK$445), emergency (A&E) admissions (HK$1,230), in-patient admissions ($5,100 per bed day). We multiplied the number of in-patient admissions with the median length of stay in hospital (3 days) to estimate the total hospitalization cost. The actual length of stay in hospital was not used when estimating the cost in the main analysis to avoid the extreme values from long-stay patients, but we used it as an alternative scenario in the sensitivity analysis. For the

control group, we used the same approach as described above to estimate the cost of training, the staff's time spent on social calls, and the health service costs. All costs were based on year 2018 rates.

Quality-adjusted life years (QALYs) were used as one of the health outcomes of the intervention. Quality of life (QOL) data was collected using the Hong Kong Chinese version of the 12-item Short-Form Health Survey (SF-12 HK). The QOL data was translated into a health utility score based on an algorithm derived from the local population [20]. The QALYs gained at 3 and 6 months were then calculated by multiplying the utility score by the length of time the subject spent in that health state, i.e. the area under the curve. Only subjects who had completed the QOL survey at all three time points were included when comparing the QALYs gained. Other health outcomes included the number of public and private GP visits, A&E and in-patient admissions, and total length of stay in hospital.

Differences between groups were compared using the Mann-Whitney U test for non-normally distributed continuous variables. The ANOVA test was used to compare the quality of life between groups and over different time points. Any significant differences in health service utilization were used to estimate the number of patients needed to be treated by the intervention in order to prevent one GP visit or in-patient admission i.e. NNT=1 / (event rate in control group – event rate in intervention group). The missing data were imputed using multiple imputation by chained equation.

Cost-effectiveness analyses

Incremental cost-effectiveness ratios (ICER) between the groups were calculated by dividing the difference in total cost by the difference in QALYs. The ICERs were compared with the willingness to pay (WTP) threshold for a QALY, which was equal to (a) £20000/QALY (approximately HK$200,000, £1=HK$10) as suggested by the NICE guideline [21], and (b) year 2018 gross domestic product (GDP) per capita in Hong Kong (HK$381,870) based on the WHO guideline, which suggested that ICERs of less than 1 to 2 times per capita GDP could be considered cost-effective [22]. Sensitivity analyses were conducted to capture the uncertainties around the cost-effectiveness parameters. One-way sensitivity analysis was performed by testing with a 30% variation higher / lower in program costs and a range of the 95% confident intervals (CI) for health service utilization (due to GP visits and in-patient admissions). We also included three scenario analyses to test 1) a wider range of costs by including the subject time spent on home visits and telephone calls, 2) applied actual length of stay in hospital for cost estimation and 3) conducted multiple imputation using chained equation based on other data including demographical and disease history to replace the missing values in health service utilization and QOL data. The probabilistic sensitivity analyses recalculated the ICER 10,000 times, selecting random values for program cost, health service utilization and health utility in each iteration. Program cost varied within +/-30% of training and intervention cost by using uniform distribution. The health service utilization and values for health utility varied based on a bootstrapping method, selecting random values from the intervention and control groups respectively.

Results

Of the 926 potential community-dwelling older adults who were assessed for eligibility, 540 participants agreed to join the program and were randomized into intervention (n=271) or control groups (n=269). At the 6-month follow-up, 41 and 40 participants were lost to follow-up in the respective intervention and control groups due to death, elderly home admission, and data collection refusal (Supplementary table). The number of public and private GP visits, A&E admissions, and in-patient admissions were lower in the intervention group. The differences were statistically significant for the number of public GP visits at 3 months and 6 months, private GP visits at 6 months, and length of stay in hospital at 3 months (Table 1). In terms of number needed to treat (NNT), the intervention needed to treat 7 subjects to remove one public GP visit and 4 subjects to remove one private GP visits in 6 months. Both the intervention and control groups showed a significant increase in QOL from the baseline. The estimated QALY gains of the intervention group for 3 and 6 months were 0.0014 and 0.0033 respectively.

The costs for the program and health service are shown in Table 2. The intervention group had higher program costs but lower health service costs at both time points. The total costs per subject for the intervention group were $2,678 and $3,979 for 3 and 6 months respectively, while the equivalent costs for the control group were $2,021 and $3,623 respectively. The incremental cost per subject for the intervention was $657 for 3 months and $356 for 6 months.

The intervention group had made some gains in QALYs. The ICER of the program was HK$456,018 for 3 months and $109,453 for 6 months (Table 3). One-way sensitivity analysis showed that the ICERs ranged from $207,226 to $704,811 for 3 months and from $-366,649 to $401,544 for 6 months. The results showed that the program can be cost-effective at 6 months

when compared to one GDP per capita (HK$381,780) according to the WHO guideline, but may be less promising using the NICE thresholds. The scenario with imputed missing values showed a possibility of being cost saving, however, the estimates could be biased as the varied value of imputed health service utilization indicated that it may not be accurately predicted by the other observed data. Figures 1 and 2 show the results of the probabilistic sensitivity analyses. The cost-effectiveness plane showed that the probability of the program being cost-saving, i.e. in the south-eastern quadrant, was 6.4% and 12.0% for 3 and 6 months respectively. The acceptability curve showed that the program had a 49.7% and 53.2% likelihood of being cost-effective for 3 and 6 months respectively when considering the NICE threshold of $200,000, and it had a 52.2% and 53.4% likelihood of being cost-effective for 3 and 6 months respectively when compared to one GDP per capita (HK$381,780) in Hong Kong.

Discussion

To our knowledge, this study is one of the few to evaluate the cost-effectiveness of a preventive self-care health management program on a general population of community-dwelling older adults. The current study showed that the likelihood of being cost-effective at 6 months is greater than at 3 months, with the 6-month measure being the sustained effect of the 3-month program. Studies suggest that most health promotion and self-care interventions require extensive time and effort for providers to build a therapeutic relationship, identify self-care deficits and risk factors for institutionalization, and maximize capacity for self-care with clients [23,24]. Even with an efficient and optimal implementation process, improvements in self-care self-efficacy and changes in preventive health behaviors take time for older adults to develop [25]. Self-care is a complicated process and requires confidence, continuous support and practice. It is not a one-off

event that can be triggered by information alone [26]. The findings of a systematic review revealed that most preventive self-care programs demonstrated favorable long-term outcomes, including improving self-efficacy and physical functioning, when a longer follow-up period such as 2-3 years was included [25-29]. It is expected that the longer follow-up period may have resulted in more positive effects, as proactive care may pan out more profoundly in the long run.

It should be noted that though findings of the current analysis have suggested that a preventive self-care health management program is cost-effective, it does not mean that it is affordable. Affordability is associated with household income, whether the intervention is covered by insurance and if there is public funding allocated to support and sustain the program [30]. Results of this study provide evidence to argue for a preventive health program that is cost-effective but the payment approach needs further deliberation.

There are limitations to this study. The analysis did not include the costs of informal care, since we did not have information on the time relatives and friends spent on caring for the older adults. The community resources and services that the older adults were receiving, such as meals-on-wheels, health talks, and counselling services were also not counted in determining the total costs.

Conclusions and implications

With the emerging of aging populations and the need to contain costs, governments and policy makers are urged to find ways to save costs and reallocate resources to cost-effective programs that can meet the considerable health and social needs of older adults. The results of this program

provided new evidence that a preventive self-care health management program delivered by nurse case managers and supported by nursing students has a potential effect on cost outcomes for community-dwelling older adults.

Declaration of Conflict of Interest

The authors have no conflicts of interest.

Declaration of Sources of Funding

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Table 1: Comparison of health outcomes at different time points

		Intervention group (N=230)	Control group (N=229)	P-value
Health service utilization				
Number of public GP visits, (mean, 95% CI)	3 months	0.11 (0.05 - 0.18)	0.22 (0.15 - 0.29)	0.003 [a]
	6 months	0.28 (0.16 - 0.40)	0.43 (0.32 - 0.54)	0.004 [a]
Number of private GP visits, (mean, 95% CI)	3 months	0.62 (0.47 - 0.77)	0.73 (0.58 - 0.88)	0.126 [a]
	6 months	1.25 (1.02 - 1.48)	1.54 (1.27 - 1.81)	0.038 [a]
Number of A&E admissions, (mean, 95% CI)	3 months	0.07 (0.04 - 0.11)	0.10 (0.06 - 0.15)	0.229 [a]
	6 months	0.14 (0.09 - 0.19)	0.22 (0.15 - 0.29)	0.105 [a]
Number of in-patient admissions, (mean, 95% CI)	3 months	0.07 (0.02 - 0.11)	0.09 (0.05 - 0.13)	0.146 [a]
	6 months	0.12 (0.07 - 0.17)	0.16 (0.11 - 0.21)	0.253 [a]
Total length of stay in hospital, (mean, 95% CI)	3 months	0.36 (0.05 - 0.67)	0.38 (0.13 - 0.63)	0.040 [a]
	6 months	0.84 (0.22 - 1.46)	0.76 (0.27 - 1.25)	0.129 [a]
Health utility				
Quality of life score, (mean, 95% CI)	Baseline	0.713 (0.692 - 0.735)	0.702 (0.680 - 0.725)	0.386 [b]
	3 months	0.769 (0.750 - 0.789)	0.747 (0.726 - 0.767)	0.130 [b]
	6 months	0.785 (0.767 - 0.803)	0.771 (0.752 - 0.790)	0.396 [b]
	Within-group comparison (P-value)	<0.001 [c]	<0.001 [c]	
QALY gained from baseline, (mean, 95% CI)	3 months	0.0070 (0.0043 - 0.0097)	0.0056 (0.0030 - 0.0082)	0.239 [a]
	6 months	0.0252 (0.0171 - 0.0333)	0.0219 (0.0141 - 0.0297)	0.380 [a]

[a] Mann-Whitney U test,
[b] ANOVA test (comparing between groups at 3 and 6 months, adjusted with baseline),
[c] Repeated measures ANOVA.

Table 2: Cost of program and health service by group

	Intervention group (N=230)			Control group (N=229)		
	N	Hourly cost	Total cost	N	Hourly cost	Total cost
Pre-program training						
Trainee (Nurse)	2	$255	$1,018			
Trainee (Student helper)	22	$99	$6,006	13	$99	$323
Trainer			$11,154			$745
Program cost	Time (min)	Hourly cost	Total cost	Time (min)	Hourly cost	Total cost
Intervention						
Nurse case manager	103	$255	$100,517			
Student helper	102	$99	$38,815	23	$99	$8,714
Administration/documentation						
Nurse case manager	20	$255	$19,518			
Student helper	20	$99	$7,611	15	$99	$5,683
Travel time costs (home visit)						
Nurse case manager	60	$255	$58,553			
Student helper	60	$99	$22,832			
Equipment cost			$24,376			
Total program cost per subjects			$1,263			$68
Subject time cost*	205	$99	$78,010	23	$99	$8,714
Total program cost per subjects (included subject time)			$1,602			$106
Health service cost	Mean	Unit cost	Total Cost	Mean	Unit cost	Total Cost
Public GP visits						
3 months	0.11	$445	$11,570	0.22	$445	$22,250
6 months	0.28	$445	$28,925	0.43	$445	$44,055
Private GP visits						
3 months	0.62	$445	$63,635	0.73	$445	$74,315
6 months	1.25	$445	$128,160	1.54	$445	$156,640
Emergency admissions						
3 months	0.07	$1,230	$20,910	0.10	$1,230	$29,520
6 months	0.14	$1,230	$39,360	0.22	$1,230	$62,730
In-patient admissions						
3 months	0.20	$5,100	$229,500	0.28	$5,100	$321,300
6 months	0.37	$5,100	$428,400	0.47	$5,100	$550,800
Total cost per subjects (program cost without subject time + health service)						
3 months			$2,678			$2,021
6 months			$3,979			$3,623

* included in sensitivity analysis only

Table 3: Main results and one-way sensitivity analyses of cost-effectiveness analysis

	3 months			6 months		
	Incremental cost (HK$)	QALYs gained	ICER (HK$)	Incremental cost (HK$)	QALYs gained	ICER (HK$)
Base	657	0.0014	456,018	356	0.0033	109,453
Intervention cost						
30% lower	299	0.0014	207,226	-2	0.0033	-706
30% higher	1,016	0.0014	704,811	715	0.0033	219,613
Health service utilization						
95% CI minimum	658	0.0014	456,626	440	0.0033	135,189
95% CI maximum	656	0.0014	455,410	272	0.0033	83,719
Quality of life score						
95% CI minimum	657	0.0014	470,658	356	0.0031	115,492
95% CI maximum	657	0.0015	442,254	356	0.0034	104,014
Scenario - Included subjects' time cost	958	0.0014	664,977	657	0.0033	201,976
Scenario - Actual length of stay	960	0.0014	666,442	1,307	0.0033	401,544
Scenario - Imputed missing values	530	0.0016	334,503	-1,237	0.0034	-366,649

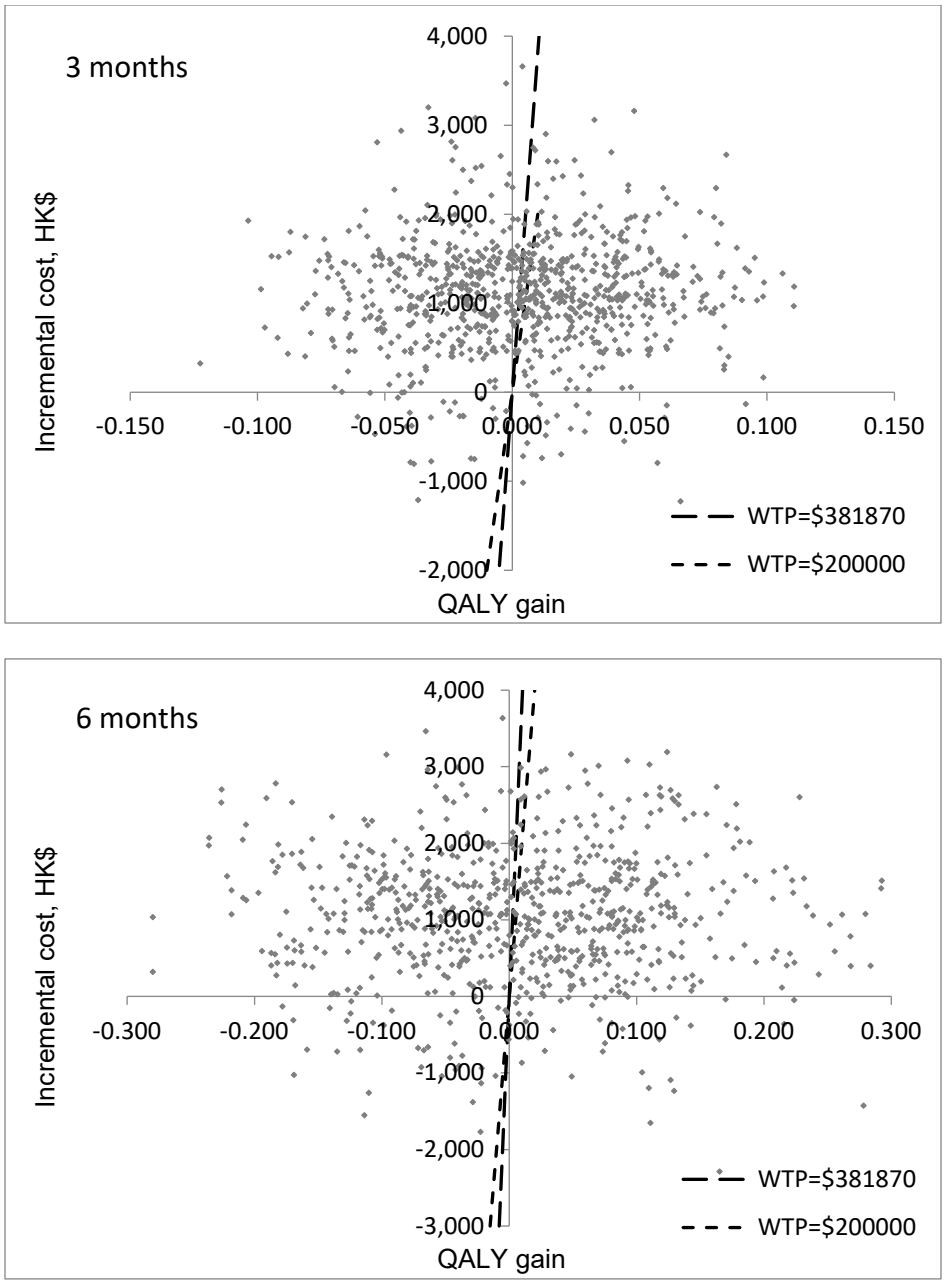

Figure 1: Cost-effectiveness plane

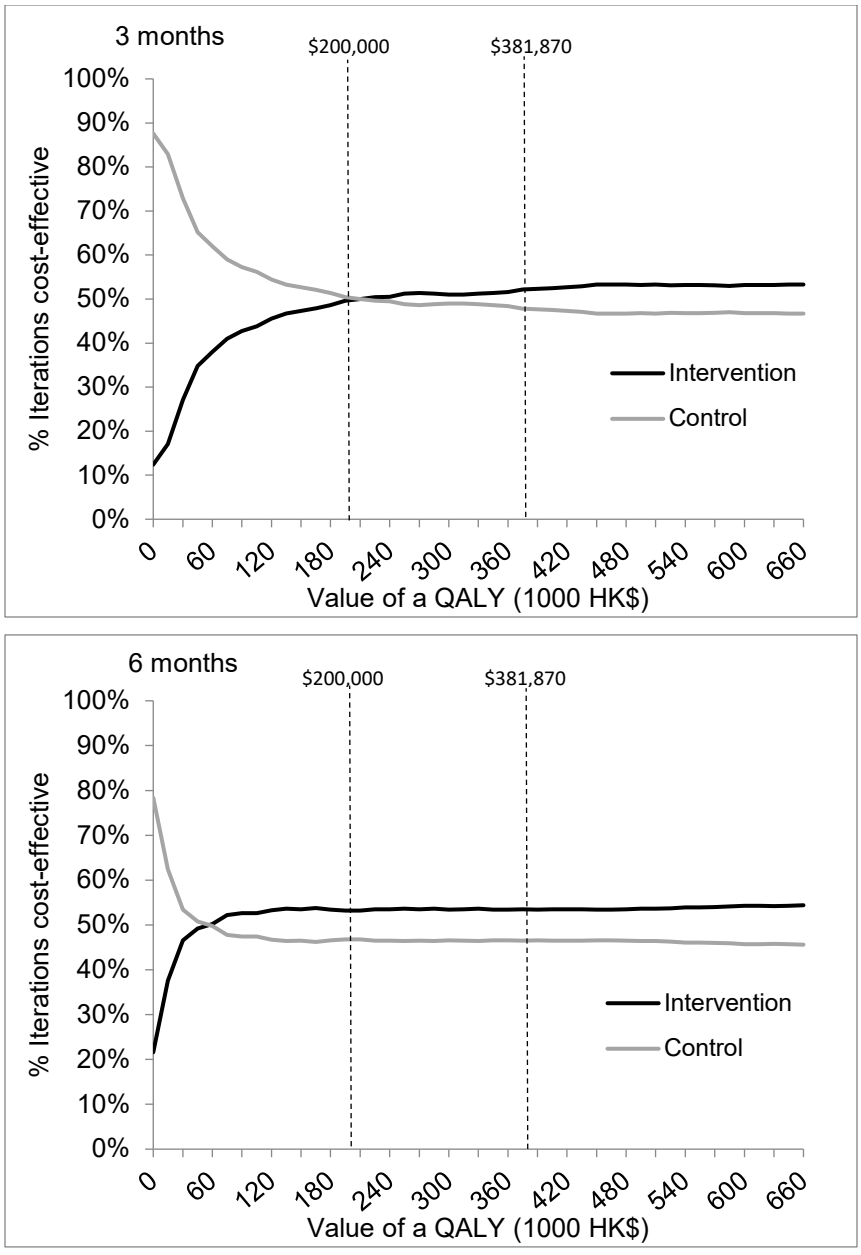

Figure 2: Cost-effectiveness acceptability curve