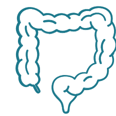

Optimizing the Dutch Colorectal Cancer Screening Program: An Evaluation of Screening Strategies Using the ASCCA Model

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Introduction

Colorectal cancer (CRC) is one of the most common cancer types in the Netherlands and causes approximately 4,500 deaths each year. Since 2014, there has been a national CRC screening programme, in which people aged 55 to 75 are invited every two years to take a stool test, the FIT. The FIT detects the amount of blood (haemoglobin, Hb) present in the stool. Participants with blood levels above the threshold value of 47 micrograms of haemoglobin per gram of stool are referred for a colonoscopy. The screening programme has led to a decrease in both the number of new cases and the number of deaths from CRC. However, challenges remain, such as declining participation in the programme, limited colonoscopy capacity, and the fact that the current stool test does not detect all cases or precursors of CRC. In addition, the number of CRC cases among younger people in the Netherlands is increasing.

Methods

This report evaluates how the CRC screening programme can be further optimised. Using a mathematical modelling tool (ASCCA), 6,884 screening strategies were analysed. ASCCA is a simulation model that mimics the natural course of CRC within a population, allowing assessment of the effects of various screening strategies on health outcomes, costs, and required colonoscopy capacity. For all strategies, the effects on colorectal cancer incidence, mortality, life-years gained, costs, and required colonoscopies were calculated.

> **Research question**
>
> **How can the Dutch population-based colorectal cancer screening programme be optimised to maximise health gains and cost-effectiveness within existing colonoscopy capacity constraints?**

Three sets of strategies were examined in which different adjustments were made to the current programme: (1) single adjustments (such as changing only the start age, threshold value, or screening interval); (2) multiple adjustments (combinations of changes, for example adjusting both the start and stop age as well as the interval); and (3) risk-stratified adjustments (in which screening is tailored to age- or sex-specific CRC risk). In addition, two exploratory analyses were conducted to examine the effect of a one-off stool test several years before the regular programme starts, as well as the effect of starting screening at age 45.

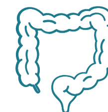

Table 1. Overview of screening characteristic configurations by strategy set						
Strategy-set		Starting ages	Stopping ages	Intervals	FIT thresholds (µg Hb/g faeces)	Number of strategies
1. Single adjustments		50,60	70,80	Annual, triennial	15,80	8
2. Multi adjustments		50,55,60	70,75,80	Annual, biennial, triennial	15, 47, 80	72
3. Risk-stratified adjustments	a. Sex	50,55,60	70,75,80	Annual, biennial, triennial	15, 47, 80	6,480
	b. Age	50,55,60	70,75,80	Annual, biennial, triennial	15, 47, 80	324

Results

1) Single adjustments

The analyses of single adjustments show that lowering the start age from 55 to 50 years yields substantial health gains and may reduce costs. Other single adjustments, such as increasing the stop age, changing the interval, or adjusting the FIT threshold value, provide only limited health gains and/or cost savings, and are therefore less efficient than lowering the starting age.

2) Multi adjustments

As shown in Figure 1, by making multiple adjustments to the start and stop ages, threshold value, and interval, the programme can be further optimised compared to making a single adjustment. The most promising multi-adjustment strategies involve a lower start age (50 years), a shorter interval (annual screening), and similar or higher stop ages (75 or 80) compared with the current programme. Each of the three FIT threshold values examined (15, 47, and 80 µg Hb/g stool) can result in an efficient strategy, depending on how they are combined with other elements of the programme, such as start and stop ages and the screening interval. Lower threshold values are associated with greater health gains and higher costs; higher thresholds with fewer health gains but lower costs.

Some multiple-adjustment strategies that yield more health benefits than the current programme also lead to lower costs. These are strategies with a lower start age (50 years), an interval of 1 or 2 years, a stop age of 75 or 80 years, and a FIT threshold of 80 µg Hb/g stool. The most efficient strategy within the set of multi-adjustment strategies is annual screening from age 50 to 75 with a FIT threshold of 47 µg Hb/g stool. This yields 41 life-years gained and increases costs by €51,000 per 1,000 individuals compared with the current programme. However, this strategy requires 57% more colonoscopy capacity over the lifetime of 1,000 individuals compared with the estimated demand of the current programme.

3) Risk-stratified adjustments

As shown in Figure 2, a risk-stratified screening programme appears to be slightly more efficient than the multi-adjustment strategies. The optimal risk-stratified strategy results in health gains comparable to the optimal multi-adjustment strategy, but at lower costs (a reduction of €25,000 per 1,000 individuals). However, the added value of risk-stratified strategies over multiple adjustments is limited. In these analyses, stratification was based solely on age and sex. Other forms of stratification, such as based on previous FIT values, may have more potential.

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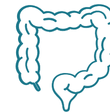


Colonoscopy capacity

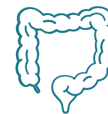
In all three strategy sets, the strategies with the greatest health gains generally require more colonoscopy capacity than the current programme. If the Dutch colonoscopy capacity cannot be expanded, or can only be expanded to a limited extent (maximum 5%), one strategy remains that is both effective in terms of health gains and costs and requires fewer colonoscopies than the current programme. This strategy consists of biennial screening between ages 50 and 80 with a threshold value of 80 µg Hb/g stool. It results in 13 life-years gained, cost savings of €96,000, and a slight reduction in required colonoscopies of 0.2% over the lifetime of 1,000 individuals.

Exploratory analyses

Finally, a one-off stool test at age 49, 50, or 51, followed several years later by the regular screening programme, may lead to health gains and even cost savings, provided a threshold value of 47 or 80 µg Hb/g stool is used. However, multiple adjustments remain more efficient. Starting screening at age 45 yields additional health gains compared with starting at 50. Some of these strategies involving screening at a relatively young age are also cheaper. These results should be interpreted with caution, as they are partly based on extrapolation. The ASCCA model is based on Dutch data from people aged 50 to 75, which introduces uncertainty regarding the results for screening outside this age range.

Conclusion

This report provides policymakers with an overview of the options for making the CRC screening programme more effective and efficient. In summary, the programme can indeed be optimised. Lowering the start age to 50 appears to be the most efficient adjustment. Making multiple adjustments, such as also shortening the interval to annual screening, can further optimise the programme. Risk-stratified screening proves slightly more efficient than multiple adjustments, although its implementation involves several drawbacks. The literature suggests that participation rates in risk-stratified programmes may be lower, potentially limiting their effectiveness. For policymakers, this means weighing the limited extra gains in health and/or cost savings against the operational burden and potential negative consequences of such strategies. If expansion of colonoscopy capacity in the Netherlands is not feasible, an efficient alternative would be biennial screening between ages 50 and 80 with a threshold value of 80 µg Hb/g stool.



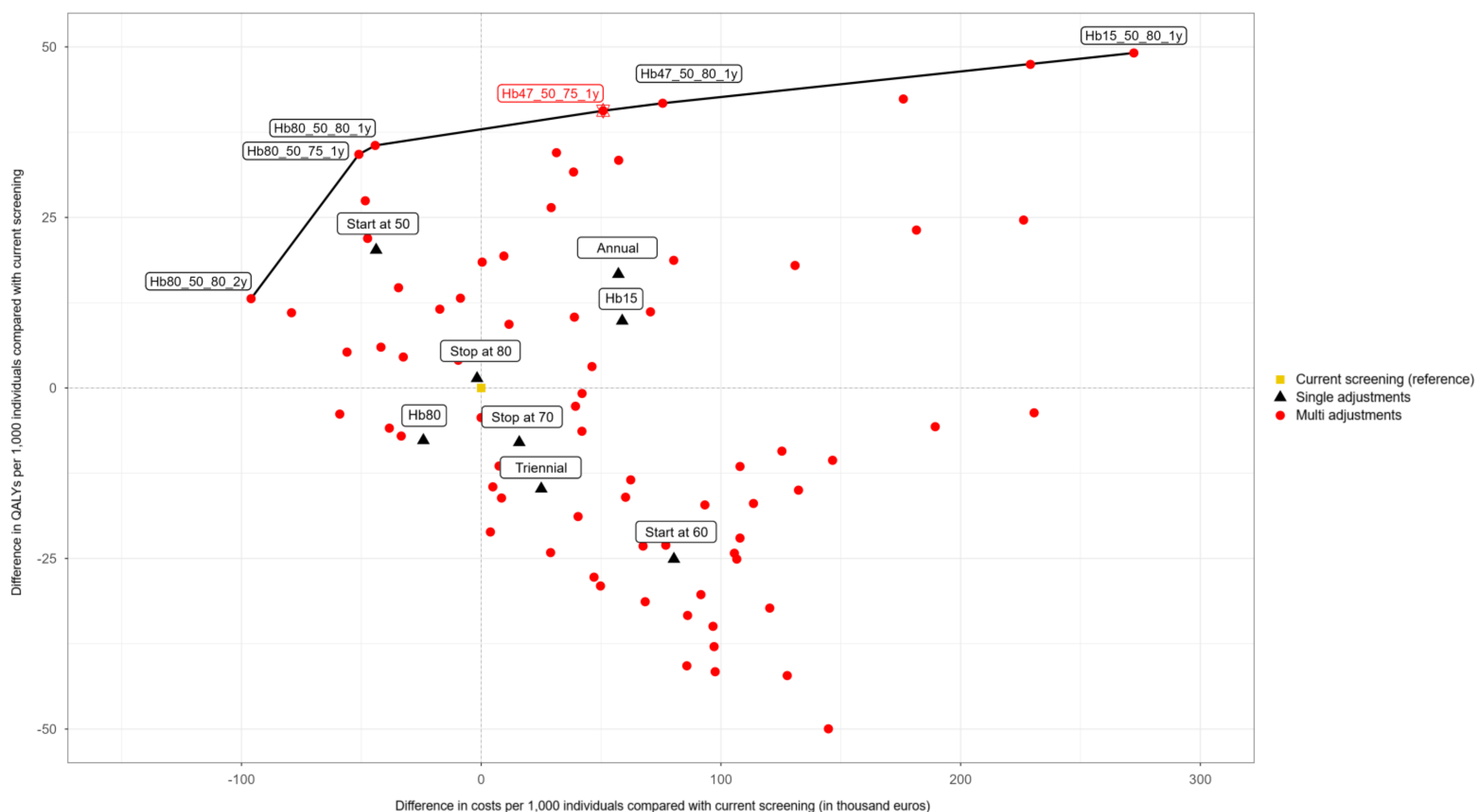
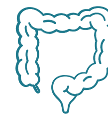


Figure 1. Cost-effectiveness plot of the single- and multi-adjustment strategy sets.
Optimal strategies from the multi-adjustment strategy set are labelled according to the FIT threshold (Hb80_), starting age (50_), stopping age (80_), and screening interval (1y). The cost-effectiveness frontier is also shown. Single-adjustment strategies are labelled according to the specific modification made to the current programme. The optimal strategy at a willingness-to-pay threshold of €20,000 per life-year gained is indicated by a red label.



Hb15_50_80_1y
Hb15to47_50_80_1y
Hb15to80_50_80_1y
Hb47to80_50_80_1y
Hb80_50_75_1y-Hb80_50_80_1y
Hb80_50_79_1yto2y
Hb80_50_80_2y

Current screening (reference)
Single adjustments
Multi adjustments
Risk-stratification (age)
Risk-stratification (sex)

Difference in QALYs per 1,000 individuals compared with current screening
Difference in costs per 1,000 individuals compared with current screening (in thousand euros)

Figure 2. Cost-effectiveness plot of the single-, multi-, and risk-based adjustment strategy sets.
Optimal strategies are labelled according to a mid-programme change in FIT threshold, for example from 47μg Hb/g to 80μg Hb/g (Hb47to80), a change in screening interval, for example from annual to biennial screening (1yto2y), or different strategies applied to men and women (Hb80_50_75_1y for men vs. Hb80_50_80_1y for women). The cost-effectiveness frontier is also shown. The optimal strategy at a willingness-to-pay threshold of €20,000 per life-year gained is indicated by a red label.