Modelling tool to support decision-making in the NHS Health Check programme: workshops, systematic review and co-production with users

Martin O'Flaherty,[1*] Ffion Lloyd-Williams,[1] Simon Capewell,[1] Angela Boland,[2] Michelle Maden,[2] Brendan Collins,[1] Piotr Bandosz,[1] Lirije Hyseni[1] and Chris Kypridemos[1]

[1]Department of Public Health and Policy, University of Liverpool, Liverpool, UK
[2]Liverpool Reviews and Implementation Group, University of Liverpool, Liverpool, UK

*Corresponding author moflaher@liverpool.ac.uk

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Scientific summary

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Background

Non-communicable diseases include heart disease, stroke, diabetes, dementia and common cancers. Non-communicable diseases account for > 90% of premature UK deaths and these are mostly preventable. Prevention is clearly the most cost-effective way of reducing the non-communicable disease burden. However, different interventions and ways of delivering prevention may vary in their effectiveness.

The NHS Health Check programme in England represents a high-profile programme to achieve this non-communicable diseases prevention goal. The programme's objective is the early identification and management of otherwise healthy people at high risk of cardiovascular disease and diabetes. It is one of the most extensive nationwide cardiovascular disease screening programmes in the world, with local authorities annually spending around £57M on commissioning the NHS Health Check programme.

Conducting an empirical evaluation of the entire programme would be challenging, time-consuming and impractical. Conversely, computational models offer a feasible approach to the task by integrating evidence and values to support decision-making. However, most previous modelling approaches to assess this type of programme have been ad hoc, short lived and proprietary, were neither comprehensive nor validated, and did not address equity issues. Furthermore, most have not considered the changing population risk profile or the interactions between diseases that share common determinants but operate on different timescales, such as heart disease compared with dementia. Finally, none of the previous models had been designed with the input of key stakeholders (the 'end-users'). A modelling engine to help decision-makers and commissioners plan and evaluate specific implementations of the NHS Health Check programme is, therefore, urgently needed.

The project aim was to develop a modelling tool to support the decision-making of the NHS Health Check programme that was co-produced with users.

Our workHORSE (working Health Outcomes Research Simulation Environment) model development has followed four strategic principles:

1. co-production (to jointly develop the model with stakeholders to explicitly identify and address their needs)
2. a robust evidence base (to explicitly link model parameters to the best epidemiological evidence)
3. up-to-date information (to exploit the growing availability of local health surveillance data and new research)
4. openness (to foster transparent analysis of the programme and to promote the continuous development of the tool by interested stakeholders).

Objectives

- Co-produce proposals with stakeholders to inform the desirable features of the user-friendly model and identify additional locally relevant scenarios to test.
- Update the evidence base to support model and scenario development.
- Further develop our computational model to allow for developments and changes to the NHS Health Check programme and the diseases that it addresses.
- Assess the effectiveness, cost-effectiveness and equity of alternative strategies for NHS Health Check programme implementation to illustrate the use of the tool.
- Propose a sustainability and implementation plan to deploy our user-friendly computational model at the local level.

Methods

Co-producing the specifications of the workHORSE model

Working with stakeholders (i.e. to co-produce the model features and uses) was at the core of model development. We operationalised this by building a stakeholder and lay advisers' group, designing four workshops guided by group model-building principles and evaluating the process.

We developed a stakeholder recruitment grid, and the project team identified relevant organisations and individuals who were then invited to participate in the workshops. In addition, we recruited four lay advisers through the National Institute for Health Research Patient and Public Involvement Network, and local Healthwatch.

Workshop design

The design of the workshop programme was theory based and used established co-production principles, including co-identifying the requirements of the decision-support tool, working iteratively during the project to co-steer the decision-support tool content and outputs, and co-developing interpretations of the decision-support tool. To guide these activities, we adapted previously validated group model-building scripts to our specific needs and context.

Our stakeholders and the modelling team completed questionnaires. These, together with the notes from meetings with lay advisers, were then evaluated using thematic analysis.

Updating the evidence base to inform model development and scenario design

The evidence base of the model comprised the epidemiology and effectiveness evidence to inform key model parameters.

To inform model features and to provide user-relevant scenarios, we explored the implementation of the NHS Health Check programme of the best-performing local authorities and looked for evidence of effective methods to increase uptake.

We selected the best-performing local authorities based on data from the NHS Health Checks Fingertips website [URL: https://fingertips.phe.org.uk/profile/nhs-health-check-detailed (accessed 4 November 2019)]. We looked at the performance of local authorities during the complete 5-year cycle, from 2013 to 2017. The main objective was to inform the coverage and uptake input parameters for the workHORSE model.

We also conducted an umbrella literature review (of published systematic reviews and meta-analyses) of strategies intended to increase the uptake of screening programmes. We adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist and registered the protocol in PROSPERO. We conducted searches of both published and unpublished reports from 1999 to 2019 in MEDLINE, Cochrane Database of Systematic Reviews, Cumulative Index to Nursing and Allied Health Literature, EMBASE, Web of Science, Health Management Information Consortium, Database of Promoting Health Effectiveness Reviews (EPPI Centre) and the National Institute for Health Research Journals Library.

We developed and refined specific data extraction forms. We included studies evaluating strategies to improve the uptake of screening programmes and excluded studies of shared decision-making or patient navigation interventions. We used ROBIS (Risk of Bias in Systematic Reviews) to assess the risk of bias for each study. Only those studies in English were included and these studies were summarised narratively according to intervention type, screening programme and strength of evidence.

Assessing the effectiveness, cost-effectiveness and equity: the workHORSE model

The workHORSE model is a computational modelling application that consists of a graphical user interface that allows user interaction, an epidemiological engine, a health economics engine and an NHS Health Check programme policy engine. The epidemiological engine of workHORSE is a validated discrete-time dynamic stochastic microsimulation, incorporating demographic and biological risk factors, as well as behavioural risk factors, producing a wide range of outputs for cardiovascular disease, common cancers, chronic obstructive pulmonary disease and post-stroke dementia.

Cost-effectiveness is estimated within the tool with a range of incremental cost-effectiveness ratio willingness-to-pay thresholds and quality-adjusted life-year valuations. Quality-adjusted life-years were calculated based on accepted population norms using the equations from the UK EuroQol-5 Dimensions Medical Expenditure Panel Survey catalogue (Sullivan PW, Slejko JF, Sculpher MJ, Ghushchyan V. Catalogue of EQ-5D scores for the United Kingdom. *Med Decis Mak* 2011;**31**:800–4).

We used a range of perspectives, including health, health and social care, and societal. The health-care perspective included intervention costs and health-care cost consequences using the excess cost for diseases and net quality-adjusted life-years. The health and social care perspective included the same as the health-care perspective with the addition of social care costs. Finally, the societal perspective included the same as the health and social care perspective with the addition of net informal care costs and production (i.e. household production and earnings).

We conducted analyses exploring the effectiveness, cost-effectiveness and equity impact of optimising the programme at the local level. The first scenario analysis explored the optimisation of the Liverpool implementation of the NHS Health Check programme by adopting best practices seen elsewhere. The second analysis looked at the impact of improving uptake based on a large randomised controlled trial. Finally, we explored the sensitivity of the model outputs when more detailed data were used as input parameters.

Implementation plan

We detail the options for implementation and highlight five essential items to consider when strategically implementing the tool in an organisation. These are:

1. the technical aspects of the implementation
2. keeping the model updated
3. training users in scenario development, implementation and interpretation
4. the resources required in terms of people and expertise
5. exploiting the possibilities of an open-source approach to future-proof the model.

Results

Co-producing model specifications

Thirty stakeholders participated in the workshops and 15 attended two or more workshops. Stakeholders represented the local, regional and national perspectives, and included attendees from local authorities, Clinical Commissioning Groups, general practitioners, academia, Public Health England and third-sector organisations (including the National Institute for Health and Care Excellence and the British Heart Foundation).

The workshop process established the added value of co-producing the decision-making tool. Workshop 1 provided the foundation for the future workshops, with stakeholders demonstrating a commitment to their involvement and the modelling team embracing the added value of the co-production process. Workshop 2 enabled both the stakeholders and the modelling team to explore how end-users would

utilise the decision-support tool. Workshop 3 enabled stakeholders to fine-tune and approve the decision-support tool. Workshop 4, the culmination of the iterative co-production process, demonstrated how the decision-support tool could be employed and aimed to enthuse stakeholders about its capabilities in practice.

Updating the evidence base to inform scenario design and model

Best-performing local authorities

We contacted 16 local authorities with an 81% survey response rate. The approaches adopted for coverage and uptake of the NHS Health Check programme varied markedly. These factors influenced how the local authorities designed and implemented strategies to increase coverage and uptake.

It was therefore not possible to establish a typical 'successful' pattern to identify a set of effective approaches that can be recommended to local authorities. However, it was apparent that all participating local authorities had taken a strategic and sometimes innovative approach to achieve targets, based on their population profile.

The information that was obtained informed the content of the stakeholder engagement workshops and also provided valuable case examples for possible scenarios for the workHORSE tool.

Umbrella literature review

We included a total of 61 reviews. Thirty-eight reviews included more than two interventions or screening programmes. The main interventions that were identified included patient education, patient invitations and reminders, provider interventions, reducing out-of-pocket client costs, reducing structural barriers and multiple interventions. Most of the screening programmes that were identified focused on breast, cervical or colorectal cancer. Research designs included randomised controlled trials, quasi-experimental and observational studies. In general, the individual reviews were at high risk of bias. The 61 reviews reported a total of 180 outcomes, particularly screening uptake, participation, adherence and test utilisation.

The most effective interventions considered in isolation included patient invitations alone or reminders alone, with each of these consistently increasing screening uptake for breast, cervical and colorectal cancer. The combination of invitation letters and a telephone reminder was even more effective. Mailing kits to patients enhanced uptake for cervical and colorectal cancer screening. Moderately effective interventions included one-to-one patient education and counselling, group education, mass media and small media campaigns alone, media campaigns combined with individual education and financial incentives for patients.

Effective provider interventions included reminders to providers, provider assessment and feedback, and training of health-care professionals.

Multiple interventions involving diverse combinations consistently appeared effective in the reviews involving direct comparisons.

Ineffective interventions included decision aids, and personalised risk communication or tailored messaging interventions.

The effectiveness evidence on several other interventions was inconclusive, including individual home visits, provider incentives, using dedicated personnel, and organisational change and procedures.

Using the workHORSE model to assess the effectiveness, cost-effectiveness and equity of alternative strategies for implementation of the NHS Health Check programme

In general, redesigning the programme in local authorities might result in modest health and economic gains. However, we observed no impact on reducing inequalities in the short term.

In the first analysis, we compared an optimised version for Liverpool of the NHS Health Check programme that focused on increasing uptake, prescription rates and increased referrals with highly effective lifestyles services. Compared with the current implementation, this could prevent approximately 220 cases (mainly cardiovascular disease), become cost-effective by 2029 and would likely be equitable.

In the second analysis, we explored the potential effect of using a more effective invitation method (a behaviourally informed invitation letter) plus an additional scenario looking at optimising lifestyle services in Northamptonshire local authorities. However, even when using this better invitation method, it is unlikely that this would be cost-effective unless other components of the NHS Health Check programme were also optimised. None of these scenarios appeared likely to reduce inequalities.

Finally, in the third analysis, we showed that using more detailed local data inputs increased model benefits.

Implementation plan

The adoption of an open-source approach will enable future evolution of the model, updating the evidence, informing the engine and enabling bespoke use for new requirements.

The critical resources for implementation will need to include technical deployment; resources to maintain, update and extend the model engine; analytical capabilities; and programme-specific expertise.

Stakeholder feedback emphasised the critical need for training to enable primary users to effectively design and interpret scenarios to explore effectiveness, cost-effectiveness and equity questions. Generating more advanced use cases would require a consultancy-based approach or access to data science, modelling and software engineering resources and skills.

Conclusions

Our results suggest that developing a computer model with end-users leads to a more user-friendly and relevant model to improve the uptake of the NHS Health Check programme.

The survey of best-performing local authorities revealed a diversity of practical approaches to maximise coverage and uptake of the NHS Health Check programme, with no single ‘best option’ readily identifiable.

The umbrella review identified a wide range of interventions that can increase screening uptake when used singly, but ideally in combination.

The workHORSE model is a microsimulation model, built on reliable epidemiology principles, with the capabilities to simulate user-designed scenarios.

We used the model to evaluate illustrative scenarios to explore the effectiveness, cost-effectiveness and equity impact of optimisation to improve critical aspects of the design of the NHS Health Check programme. Improvements are likely to generate gains in health and cost-effectiveness, but may not necessarily improve inequalities.

The implementation of the tool will need to focus on its information technology aspects, keeping the model updated, training users in scenario development and interpretation, procuring resources in terms of people and expertise, and fully exploiting the possibilities of an open-source approach.

Study registration

This study is registered as PROSPERO CRD42019132087.

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This report

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