

Harnessing data and technology for public health: five challenges

Responding to the government's prevention green paper

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Introduction

In this long read, we set out five challenges that the government needs to address if it is to harness the full potential of data and technology in public health, and offer a suggestion to help address each.

Technology and data have revolutionised so many areas of our lives, it is natural to ask what they can do for public health and prevention. Public health professionals have always used data to understand the health of populations and galvanise change as a core part of their approach.

But today, some people feel that the scale of new data sources, advances in genetic sequencing, machine learning and artificial intelligence (AI) could usher in a new era of more personalised interventions underpinned by more precise risk prediction. The same data and technology have the potential not just to achieve greater personalisation but also to transform our understanding of the risks facing populations so that we can take action.

Given the interest in this area, and recent announcements of large-scale NHS investment in AI, it is unsurprising that better use of data and technology are central themes for the government's prevention green paper [Advancing our health: prevention in the 2020s](#).

What the green paper says about using data and technology

The green paper presents the use of technology and data as a major opportunity for improving public health in future. It advocates a 'new prevention model' that is 'proactive, predictive and personalised', with a vision of 'a new wave of intelligent public health where everyone has access to their health information and many more health interventions are personalised'. [See page 3](#)

Specific proposals include greater use of genomics in health care, a review of the NHS Health Check and the first phase of a 'predictive prevention' work programme by Public Health England and NHSX.

The predictive prevention programme is intended to evaluate and model predictive prevention at scale, working on two key areas:

- developing exemplar projects to prove the concept of personalised prevention and establish the evidence base
- designing the future shape of the programme, with a view to increasing the scale and ambition.

[Read in full](#)

In this long read, we set out five challenges that the government needs to address if it is to harness the full potential of data and technology in public health, and offer a suggestion to help address each. The challenges are:

1. balancing interventions that reduce individual susceptibility versus interventions that tackle the underlying causes
2. balancing universal interventions against targeted approaches
3. making prevention services accessible to those who need them most
4. closing the evidence gap between prediction and prevention
5. balancing investment in novel solutions against funding tried-and-tested solutions.

The hope, set out in the green paper, is that new, 'smarter' approaches to prevention will help address entrenched problems (such as health inequalities) and worrying trends (such as the stalled improvements in life expectancy). However, if real progress is going to be made in improving the

public's health, history tells us that some fundamental tensions in public health policy and practice need to be addressed.

1. Reduce individual risk or tackle underlying causes?

Organised approaches to improving public health have always combined two types of intervention:

- those designed to reduce the risk faced by individual people
- those targeting underlying causes of incidence in populations.

There are good reasons – both theoretical and empirical – to believe that, while both approaches are needed, those that address the underlying causes have the biggest impact on population health. By focusing on 'personalisation', the green paper's vision for data and technology falls into the former category, limiting its potential impact.

Understanding individual risk versus underlying causes in populations

It can be helpful to distinguish between the underlying causes of the rate of an illness in a population and the factors that determine which individuals are affected by that illness.

For example, in the 19th century the level of cholera was driven by factors such as availability of clean water, sanitation and population density. Which individuals were most affected within the population, however, was determined by a different set of risk factors, such where they lived, which water source they used, and how they used water.

Epidemiologist Geoffrey Rose explored these different types of causation in his 1985 seminal paper on public health strategy, [Sick individuals and sick populations](#). Rose described two distinct drivers of illness:

- determinants of incidence rate (the underlying causes of disease)
- determinants of individual cases (or individual susceptibility).

These drivers can be addressed through two corresponding public health strategies:

1. the population approach, which addresses the causes of incidence
2. the high-risk approach, which tries to protect susceptible individuals.

Since the beginning of the discipline, both of these strategies have been employed as part of an effective public health approach.

Rose concluded that: 'The two approaches are not usually in competition, but the prior concern should always be to discover and control the causes of incidence.' In other words, priority should be given to the underlying causes in populations because the vast majority of cases of illness occur in individuals at moderate risk rather than those at the extreme end of the spectrum. Thus, shifting the curve by a small amount will have much bigger impact on health at population level than focusing on those at highest risk.

[Find out more](#)

There may be some gains to be made in reducing risk to individuals, but there is a real danger that this focus promotes a reductive model of public health that focuses on individual behaviour rather than the wider (social, economic, environmental and commercial) determinants.

Here it's useful to consider how we tackled the big health problems in the past. Victorian reformers and innovators brought clean water, improved housing and sanitation to Britain's cities.

Transmission of infectious diseases such as cholera was eliminated through major reforms that tackled structural issues – including through novel uses of data such as cutting-edge approaches to mapping and [visualisation](#).

As well as improving health generally, this focus on underlying causes reduced health inequalities. This is because it brought far greater benefit to those communities that were more deprived, as it was they who had borne the brunt of poor water quality and overcrowding. Reformers did also promote individual-level approaches, such as sharing good hygiene practices (such as handwashing, boiling water and using antiseptics). These will have benefited many people at an individual level, but with a much smaller impact on overall population health and inequalities.

Today's major public health challenges may appear more complex, but we can apply similar principles. There is abundant evidence that the strongest drivers of population health and health inequalities are not individual-level factors but structural issues such as income, education, housing and clean air: the [wider determinants of health](#). These influence the health of populations powerfully – not only because they affect whole population groups but because they are '[the causes of the causes](#)': that is, they strongly influence individual-level risk factors.

Take obesity, for example. Supporting individual behaviour change (for example, through weight management programmes) may be of real benefit to individuals. But [evidence](#) suggests that major population-level changes are only likely to happen when the structural determinants that create an obesogenic environment are also tackled effectively. For example, the levy on manufacturers has incentivised a [28.8% reduction in sugar content of drinks affected by the levy](#).

The sugar levy can be seen as an effective measure to address an underlying cause of incidence. However, even this measure on its own has not been enough to reduce significantly the sugar content of people's total diets. This is because their [average intake of sugar from foods that are not subject to an industry levy has increased](#). So, reducing exposure to unhealthy food and drink products has potential to have significant population-level impact but requires a wide-ranging, whole-system approach.

Conflating risk prediction with personalised prevention

In the green paper, the data and technology solutions focus on addressing individual susceptibility – especially by giving people with information and personalised intervention. Indeed, this emphasis is so strong that the green paper risks conflating risk prediction with personalised prevention entirely.

However, to make a real impact on population health and health inequalities it will be necessary to apply data and technology to the [wider determinants of health](#).

This could include, for example, investing in local public health teams' ability to understand and track changes in the wider determinants in their population. New streams of data on issues such as air pollution, accessibility of green spaces, data from across government services, and acute problems such as drug use or changes in the labour market are becoming easier to collect at scale, and could all be useful.

Similarly, new data could help give local and national policymakers a more sophisticated understanding of commercial determinants, such as the availability and pricing of food and drink. Meanwhile, there are a number of emerging public health concerns that are fundamentally digital issues, such as online gambling, the impact of social media on mental health, and vaccine hesitancy. These, too, are likely to need population-level digital solutions.

Focusing on individual susceptibility may seem like a quicker and easier solution than addressing underlying structural issues. Policymakers are often understandably attracted to interventions that are relatively easy to implement and likely to have a short-term impact. However, if it is to make significant long-term improvements in health the government needs a sophisticated understanding of wider determinants. And making the most of these opportunities requires [investment in technical tools](#) (for data collection, dissemination and analysis) as well as in the skills needed for data analysis – which is extremely challenging given the cuts to the public health grant in recent years.

The government needs to focus on what will have the biggest impact on population health, addressing wider determinants of health, not just individual-level susceptibility.

2. Universal versus targeted interventions

A key problem in prevention work is ensuring that interventions reach those who are most likely to benefit. This issue is less about what causes to target and more about how wide to cast the net. Many see better targeting of prevention interventions as one of the main benefits of introducing new data and technology to public health and prevention, but there are challenges with this approach.

Screening programmes

In one example, the green paper proposes 'reviewing the NHS Health Check and setting out a bold future vision for NHS screening' to make it more targeted. This is because, while screening programmes make great intuitive sense and are [generally popular with the public](#), balancing their costs and benefits is [complex](#), and there is clear [evidence](#) that, if applied inappropriately, screening can do more harm than good.

The decision to overhaul NHS health checks is welcome given the [limited](#) evidence for their effectiveness and cost-effectiveness. But finding a more effective way of using health checks will need investment and careful consideration of the costs and benefits.

While the evidence on more targeted health checks is yet to be developed, there is some evidence for other forms of screening. For example, a modelling study on breast-cancer screening suggests that moving from the current age-based screening strategy to a risk-based approach could improve cost-effectiveness, reduce overdiagnosis and maintain the benefits of the current screening programme.

Risk for health inequalities

But a key challenge for greater targeting of prevention interventions will be their impact on health inequalities. For example, the current NHS Health Check programme is effectively universal for 40–74 year olds. However, as people who take up health checks tend to be [healthier than the general population](#), the programme brings more benefit to people who had better health in the first place.

It is possible that technology and data may be able to help with these problems. For example, linked data could be used to target and monitor the impact of health checks in marginalised groups. This on its own may not address inequalities in access but could be used alongside tailoring, community engagement and behavioural science approaches to ensure that people who are currently missing benefit more in future.

Approaches of this kind, however, need to be tested. If risk prediction is to be used to make prevention strategies more targeted, this approach must be based on robust evaluation of costs and benefits, and must be designed to ensure that they have a positive, not a negative, impact on health inequalities.

The government needs to find the right balance between universal versus targeted interventions. There may be some benefits to greater targeting of existing services, such as screening, but the costs and benefits need to be weighed carefully and evaluated robustly.

3. Ensuring access for all

As we saw in the last section, the groups that are targeted (those to whom the services are offered) are not always the people who ultimately benefit from them. Health checks that are offered to the whole population often rely on individuals engaging first with the check itself and then with follow-up health promotion initiatives.

This is inequitable because people living in socially and economically deprived circumstances can find it more challenging to make use of these initiatives. For example, people living in more deprived areas or with fewer social connections are less likely to participate in preventive health services including some [cancer screening programmes](#) and [routine health checks](#).

In this area, technology offers opportunities but also challenges, which we explore through two examples.

Switching services to digital challenges

Moving services to digital channels could expand access to care, reduce stigma of accessing them, or help people fit them in around work and family commitments. However, this also raises the risk of digital exclusion. The [Good Things Foundation](#) estimates that 7.8 million people in the UK never use the internet and a further 7.4 million people use it infrequently and may find more advanced uses of the internet challenging. Older people, those living with disability or chronic illness, and those with lower levels of education or on a low income are more likely to be non-users or limited users. Technological solutions that depend on users having sufficient skills to access them may exclude many of those who are most in need.

Using data to target high-need groups

Another use for data-driven technology could be to identify and target those who are not currently reached by prevention interventions. If initiatives can use linked data to target and monitor the impact of the health checks in marginalised groups, this could help reach the people who are currently missing out.

However, there is a problem with the data systems that could be used to do this: they often reflect the structural inequalities in our society. For example, [many risk-prediction innovations are based on genetic datasets that have historically excluded many populations](#). People of European ancestry make up [79% of all participants of genetic studies](#). Steps are being taken to improve this, but [tests available](#) today may still exclude certain groups.

Biases in data

Similarly, even in a health system that provides universal access, like the NHS, electronic health records will contain biases. For example, some groups [may be less likely to seek treatment](#), or may [receive a different diagnosis if they do](#). So, their needs will not be captured in the data. So, algorithms can perpetuate or [reinforce existing biases](#) in risk assessment processes.

There is a real risk that the people who are least able to access appropriate health care are the most likely to be under-represented in data sources. So, balancing the benefits of data and technology solutions against the risk that they will exclude some populations is a major challenge.

It is important to apply data and tech solutions in ways that reduce health inequalities and benefit those most in need. This includes addressing explicitly the impact of new solutions on health inequalities, taking into account the barriers that some groups face in accessing preventative services.

4. The prediction–prevention gap

Having assessed who is at greatest risk, the next challenge for public health is to convert this knowledge into effective strategies to prevent illness. Understanding risk is important but, as the history of tobacco control shows, using that information to produce better population health can be surprisingly difficult.

More accurate, and more personalised, risk prediction is one of the main areas that the green paper highlights as an application of data and technology for prevention. It is true that linking large datasets, using advanced analytical techniques and incorporating genetic information, promises more granular prediction of risk than ever before. At the same time, information technologies provide more channels than ever for getting that information to individuals and health care professionals.

What is less clear, however, is how all this will help improve people's health. It isn't yet clear how new risk prediction from genetics and other data sources can be effectively deployed as part of a prevention strategy. At present, there is a prediction–prevention evidence gap.

Risk information for behaviour change

One approach promoted in the green paper is to give individuals more information about their risk of disease, in order to motivate behaviour change. However, existing evidence suggests that simply giving people more risk information has little or no effect on their behaviour.

Can risk information change behaviours?

The evidence

A systematic review by [French et al](#) found that communicating disease risk information to patients – even when highly personalised – does not produce strong effects on smoking, physical activity, diet or alcohol consumption. Similarly, [another systematic review](#) found that communicating genetic risk information had no impact on a range of health-related behaviours.

Further evidence on giving health care professionals and patients risk estimates for [cardiovascular disease](#) and [cancer](#) found that, although it might increase the accuracy of their risk perception, it had little effect on health-related behaviour.

Data to personalise interventions

A second approach that it promotes is to provide new information to clinicians or public health professionals, to help them target individuals for intervention, or to tailor a programme of preventive care. This approach is already used by the NHS, which applies risk-prediction tools to help clinicians

identify and refer patients and to segment the population when designing and delivering care pathways.

Like screening, this approach seems intuitively advantageous but may not always be effective in practice. One example was the PRISM (Predictive Risk Stratification Model) system, which provided information to GPs in Wales about which patients were at highest risk of hospital admission. [Trials](#) found that use of this tool was associated with an increase in hospital admissions of around 3% over 12 months, but without clear benefits to patients.

A further issue is that risk prediction can only be converted into better outcomes if other factors are in place – for example, in this case, if GPs had access to the right preventive community services. If better risk prediction is to be converted into more effective prevention, this depends on a wide range of factors, both inside and outside the health system.

It is too simplistic, therefore, to assume that what Public Health England describes as '[sorting people into more precise groups according to their risk for common conditions](#)' will automatically improve health and prevent disease. To make the most of the opportunities, the government needs to address the gap between prediction and prevention and apply the predictive capabilities of new technologies alongside proven interventions, as we explore in the next section.

It is essential to address the prediction–prevention evidence gap. More granular calculation of risk doesn't automatically translate into more effective prevention or improved health. Robust research and evaluation is needed to develop the evidence base bridging this gap.

5. Novel solutions versus tried-and-tested ones

The green paper emphasises the potential of new technological to improve prevention. But it is important to balance this against the many existing interventions that have a proven track record.

Established interventions

There is strong [evidence](#) for the effectiveness and cost-effectiveness of a wide range of preventative interventions that are currently under-funded, ranging from smoking cessation to [Sure Start Centres](#). Decisions about investing in new technologies must be made in the context of what we already know about the value of existing interventions that could be deployed with no further evaluation. Investment decisions also need to take into account the impact of novel interventions on equity.

Similarly, there are established methods for comparing the cost-effectiveness of existing interventions. In comparison, it is less clear how to make rational decisions about how much resource (including time and money) to invest in developing novel solutions for public health problems. Seizing promising opportunities for the future while avoiding the potential to be carried away by hype requires complex judgements to be made.

Proportional investment

A key challenge is to ensure that any investment is proportionate. Understanding the potential population-level impact of new data and technology approaches to prevention could help with this.

This strategy is already used for national screening and vaccination programmes, with simulation models assessing the potential impact of new interventions (or ways of deploying existing interventions, such as risk-based screening strategies). Similar modelling can be used in public health, to inform the use of new predictive prevention techniques.

It will be important that new interventions are compared not only against 'do nothing' scenarios but against existing prevention interventions that have a strong evidence base. This will allow informed decisions to be made about where to invest limited resources.

Another way of ensuring appropriate levels of investment is to ensure that the impact of new technologies is evaluated robustly and [rapidly](#), to demonstrate effectiveness and refine quickly for improvement. Without this, there is a high risk of scarce resources being put into a programme that is not effective or cost-effective (as happened with NHS Health Checks) due to a lack of robust evaluation and research.

It is important to balance investment in novel technological solutions with the need for ongoing investment (or reinvestment) in tried-and-tested prevention methods. Effective

use of modelling methods and robust, rapid evaluation can help ensure that scarce resources are not poured into solutions that have little or no impact on population health.

Conclusion

There is clearly real potential for data and technology to help keep people healthy and prevent illness. Indeed, this is already happening. But there are also dangers, such as the potential for novel solutions to increase health inequalities, and there are real opportunity costs.

This document sets out the following five challenges with taking forward the vision for data and technology, as set out in the green paper:

- The government needs to focus on what will have the biggest impact on population health, addressing wider determinants of health, not just individual-level susceptibility.
- The government needs to find the right balance between universal versus targeted interventions. There may be some benefits to greater targeting of existing services, such as screening, but the costs and benefits need to be weighed carefully and evaluated robustly.
- It is important to apply data and tech solutions in ways that reduce health inequalities and benefit those most in need. This includes addressing explicitly the impact of new solutions on health inequalities, taking into account the barriers that some groups face in accessing preventative services.
- It is essential to address the prediction–prevention evidence gap. More granular calculation of risk doesn't automatically translate into more effective prevention or improved health. Robust research and evaluation is needed to develop the evidence base bridging this gap.
- It is important to balance investment in novel technological solutions with the need for ongoing investment (or reinvestment) in tried-and-tested prevention methods. Effective use of modelling methods and robust, rapid evaluation can help ensure that scarce resources are not poured into solutions that have little or no impact on population health.

These challenges must be addressed if new data and technology solutions are to have a real impact on population health. If we are to make the most of the opportunities, the government's vision of new data and technology for public health must move beyond personalisation and consider the wider potential to improve the public's health.

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Notes

- This long read was published originally at 15.45 on 8 October 2019 at the following address: <https://www.health.org.uk/news-and-comment/blogs/harnessing-data-and-technology-for-public-health-five-challenges>