NATIONAL PREVENTION RESEARCH INITIATIVE

INITIATIVE OUTCOMES AND FUTURE APPROACHES

September 2015

NATIONAL PREVENTION RESEARCH INITIATIVE (NPRI)

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A REPORT BY AN INDEPENDENT SCIENTIFIC REVIEW GROUP COMMISSIONED BY THE FOLLOWING FUNDERS OF THE NPRI

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The data annexes and NPRI call details are available online.
Please refer to www.mrc.ac.uk/documents/pdf/npri-report-2015-annexes

1. Executive summary

1.1. The NPRI and the NPRI review

The National Prevention Research Initiative (NPRI) was established by 11 research funders including government departments, research councils and medical charities. Through four funding calls (between 2005 and 2011), NPRI-funded research aimed to reduce the burden of chronic non-communicable disease by investigating the role of health-related behaviour, particularly alcohol consumption, smoking, diet and physical activity. The initiative also aimed to build capacity for public health prevention research. By the last call, the NPRI partners (by then 16) had committed £34m to 74 projects. By 2014, almost three quarters of projects had ended, with 55 per cent having finished between 2007 and 2011.

In February 2014, the funders established a Scientific Review Group (SRG) to review the outputs from individual projects and the strategic impact of the initiative as a whole. The SRG was also tasked with advising on future opportunities in prevention research in the light of the changed landscape for funding public health research. The review included extensive consultation with NPRI-funded investigators, current funders, and leaders in the scientific field.

1.2. What the NPRI achieved

The NPRI has supported a portfolio of good quality research with notable highlights. In terms of the scientific questions asked and approaches adopted to answer them, the portfolio had good diversity. All of the core behaviours that the NPRI sought to address were covered, although relatively few studies focussed on prevention in lower socioeconomic groups or in minority ethnic groups. A high percentage of completed projects met their stated objectives when judged against their reports and published work. Some studies had employed innovative approaches, particularly for obtaining objective data.

By the time that data collection for the review was completed (August 2014), the NPRI had generated between four and five scientific papers per project on average, with publications still emerging. Some papers had been highly cited although it was too early to complete a full citation analysis. Nine studies from the first three calls had not yet produced any publications.

A number of studies had achieved high impact from their work. For example, 13 had produced evidence to underpin policy or practice change, which had been effectively disseminated. Many others had produced more incremental advances which had nonetheless made useful contributions in important areas of public health. Given the relatively small size of the research portfolio, the level of influence on policy and practice arising from the NPRI was considered to be good.

An explicit aim of the NPRI was to build capacity in public health prevention research. Evidence that the NPRI had achieved this ambition included the acquisition of new skills by the NPRI PIs[1], additional grant funding including studentships, and development of new collaborations (sometimes with disciplines not traditionally associated with public health research at the time). Many NPRI-funded investigators reported that the multi-funder nature of the NPRI had raised the profile of public health research and influenced their ability to form new scientific and policy/practice networks. There had been little evidence of cross-disciplinary prevention research activity before the NPRI. The initiative had undoubtedly influenced a significant change towards more collaborative patterns of working in this area. Crucially, the initiative created a focus on behaviour and prevention that had not existed previously. It had also demonstrated that a large number of funders can work

together effectively, over a long period, to address common challenging issues. The prestigious profile of the NPRI had enabled some funders to support aspects of public health prevention research that previously would have been outwith their remit or usual range of activities.

1.3. Future directions

Research challenges and opportunity

Achieving substantial improvements in chronic disease prevention through research into behaviour and behaviour change has been, and remains, challenging. This review notes the paucity of interventions which produce large and sustained change in the 'real world'. Findings from a small number of NPRI funded intervention studies, and research elsewhere, suggest modest improvements in public health from interventions applied to individuals when targeted at change in single health-related behaviours such as poor diet, physical inactivity, smoking or alcohol misuse. Larger effect sizes may be achieved by the use of theory-based interventions. Greater reductions in the population illness or health risk could result from applying these interventions at multiple levels (individual, group, community and/or population-level). Work is also needed to understand how individual components of complex interventions fit together, and how the effectiveness of different elements can be boosted. Better use of trial methodology and iterative cycles of intervention development and process evaluation that take account of what works, for whom and in what circumstances and aspects, should be encouraged.

The SRG also agreed that there needs to be better understanding of the complex interaction between individual behaviour and risk factors, and social, cultural, health-care and other determinants of health; factors which often interact in a non-linear fashion and which sometimes operate in opposite directions. Such understanding will assist with the identification of novel interventions and points at which maximum benefit may be derived. This complexity was rarely addressed in the current NPRI portfolio and should be an important focus of future work. Researchers wishing to address these issues may be helped through the greater use of large scale individual-level and population-based datasets (including asset maps), and the use of new techniques for objective monitoring (for example through the use of digital and mobile technology).

Another important theme for future research was exploration of how to better integrate and align policies, organisations and systems to achieve health improvement. Work is needed into the development, testing and sustainable implementation (if found to be effective) of 'prevention systems' in which organisations and sectors (e.g. NHS, social care, third sector, independent sector, education) work together to create novel ways of preventing or reducing the impact of public health problems.

Key areas to be addressed in any future NPRI calls include work to narrow health inequalities and research into mental health and wellbeing.

How to effect better translation and knowledge exchange

The impact of the NPRI on policy and practice has been good. Nevertheless, more could be done to enhance the translation of findings into policy or practice, and other knowledge exchange activities, thereby accelerating the impact of future work. Both funders and researchers have important roles in facilitating the translation of research findings into policy or practice. Whether linked to specific projects or broader issues, the synthesis, translation, communication and implementation of research evidence remains an important priority. Improved resources, methods, structures and processes are needed for summarising evidence for decision makers.

There was no mechanism within the NPRI for facilitating knowledge exchange and the NPRI-funded researchers who appeared to be most effective in this area were already well embedded in policy and practice networks, and familiar with the co-production of knowledge. Outside such networks, the potential for impact was very dependent on the skills and motivation of individual researchers. There is a need to build capacity and skills in knowledge exchange. Best practice shows that both research and policy/practice benefits from early academic and stakeholder collaboration, and the co-production of knowledge. As well as exposing future recipients of prevention research funding to this best practice, practical help may be needed to help them build appropriate networks at the design as well as other stages of the project. Collaboration at the project level needs to be complemented by dialogue between funders, policy-makers and researchers about policy context, priorities, and research focus.

1.4. The continued importance of public health prevention research in the UK

During the period of the NPRI funding, spend on public health prevention research doubled, with the expectation of a further increase in the next Health Research Analysis. This is from a small base. While the increased availability of relevant research funding has put the public health research community in a better position to conduct novel, impactful work, major public health challenges remain. In some areas (for example some aspects of health inequality) the challenges have worsened. Although the NPRI has helped catalyse activity in public health research, there continues to be a relative paucity of behavioural and prevention research. The SRG concluded that there continues to be a crucial need for public health prevention research and sustained investment to strengthen further the research base so that innovations to tackle major public health challenges can be developed, tested and implemented, to produce sustainable change.

1.5. Conclusions and recommendations

The SRG agreed that the NPRI was an original and impactful funding initiative that had unquestionably strengthened UK public health prevention research. The NPRI has been important in terms of both researcher and funder profile, it has successfully supported good quality research and influenced policy and practice. Given the level of investment, which was shared between many partners, the NPRI has been very good value for money.

Public health prevention research has benefitted in the years since the start of the NPRI, through the increased availability of research funding and dedicated capacity building schemes. Some funders have started their own initiatives in primary prevention. As a consequence, the research community is now better placed to address major public health issues facing the nation. Advances in the aggregation, analysis and interpretation of large scale data, and new methods for its collection, are likely to provide future prevention researchers with the opportunity to achieve greater scientific and health impact than before. Nevertheless, achieving substantial,

sustainable improvements in disease prevention remains challenging and continued investment through a variety of mechanisms is needed.

A successful programme of public health prevention research involving concerted, multi partner collaboration is needed as much today as in 2005 when the NPRI started. Scale and stability of funding, multidisciplinarity,and researcher-user cooperation remain essential. Future programmes of work should build upon the solid foundations laid down by the NPRI as follows:

- The funded work should involve a balance between observational, developmental, and intervention studies, with increased emphasis on solving problems rather than simply describing them. Future programmes should have greater focus on developing interventions that may act at a level other than the individual (e.g. at group, community or population-level), or at more than one level.

- There also needs to be more work on the cost-effectiveness of public health prevention strategies, as well as the modelling of likely long term impact on disease outcome. A key priority is research into the development and testing of interventions in groups with particular needs, such as those with poor mental health, and in lower socioeconomic and minority ethnic groups.

- Support should be given to researcher/practitioner teams to effect sustainable change. There should also be strengthened engagement and collaboration between research funders and researchers to build capacity and expertise in knowledge exchange. In parallel, funders should set clear expectations of publication and dissemination of findings from the work (including of negative results), and participation in knowledge exchange activities.

Suggested research themes for future work were:

Improving interventions to change health-related behaviours

- Increase research into the mechanism(s) of action, context, and delivery of interventions. Capturing data from aligned behavioral studies and greater exploration of external context or timing of the intervention would help inform the development of stronger intervention plans. The use of more imaginative trial designs could make individual and group level interventions more effective and/or support better targeting or adaption to sub-groups.

- Support for researcher/practitioner teams to engage in cycles of development and testing and use knowledge based on implementation science and evaluation of process, as well as economic analyses.

Understanding complexity in public health interventions and evaluations

- Increase research into whole system influences on behavior and public health, to achieve deeper understanding of the complex influences and interactions that will support the development of more powerful individual and population-level interventions.

Assessing whether social and sector-based 'systems' can improve public health and reduce health inequalities

- Explore how to better integrate and align policies, organisations and systems to produce 'prevention systems' to create novel ways of preventing or reducing the impact of public health problems.

2. Introduction

2.1. The National Prevention Research Initiative (NPRI)

The National Prevention Research Initiative (NPRI) was a UK research funding initiative comprising government departments, research councils and medical charities. These agencies provided the funding for four calls for grant applications which were launched between 2005 and 2011. The aims[2] of the NPRI were to:

1. provide additional funds and infrastructure support to increase the amount of high-quality research aimed at preventing new cases of major preventable diseases.

2. encourage and facilitate cross-disciplinary collaborations in UK public health preventative research.

3. encourage research aimed at risk reduction, especially in communities or social groups with a high incidence of preventable diseases or conditions, and explore approaches to reduce inequalities in the incidence of these diseases or conditions.

2.2. The NPRI review

The funding partners decided in February 2014 to review the progress of the NPRI, both in terms of the outputs from individual awards and collective strategic impact. The NPRI partners agreed the terms of reference for the review on the 11 February 2014. They established a Scientific Review Group (SRG – see section 3.2) and agreed the governance for the review and the inputs to provide to the SRG. These requirements were set down in a jointly agreed mandate.

The SRG's role was to review the progress of the NPRI towards meeting its objectives. It was also to advise on future opportunities in public health prevention research in the light of the NPRI's impact and developments in the research funding landscape since 2005. The funders agreed that the report should be published, for open discussion.

2.3. Purpose and structure of this report

This report summarises the process of the review and provides basic descriptive information on NPRI funding and outcomes. Most importantly, it reports the SRG's assessment of the outcomes and future opportunities. The scope and mode of working are set out in Chapter 3. Chapter 4 describes the NPRI funding rounds and the portfolio of research grants. Chapter 5 deals with the outcomes of NPRI projects and their impacts (as at August 2014), and case studies demonstrating the diversity of impacts are laid out in Chapter 6. Chapter 7 deals with the wider impact of the NPRI partnership model. Finally, the SRG's advice on future funding opportunities is in Chapter 8.

3. Scope and process of the review

3.1. Terms of reference

The terms of reference for the review were as follows:

Scope and objective

- To evaluate whether the initiative has achieved its aims and its overall legacy.
- To assess outputs from individual awards in terms of science and generating evidence that could be used to inform policy and practice, and to make recommendations for future opportunities in public health prevention research.
- To produce a report of the evaluation and recommendations.

Evaluation

- Through qualitative and quantitative analysis, to evaluate the output of individual grants and the impact of the initiative as a whole.
- The review will evaluate:
  - Whether the NPRI has met the initial aims set by the funders.
  - The outputs both scientifically and for knowledge transfer, for example in providing evidence which has contributed to or might be used to inform both policy and practice.
  - The value of the funding model, its legacy and the contribution of NPRI projects to scientific knowledge. The review will also evaluate the funding model's contribution to innovation in this area, developing methods, tools and products that could be applied more widely.
  - The effectiveness of the funding model in comparison to other emergent models of funding prevention research. In particular to assess the impact that multiple funders have had in raising the profile of, and facilitating, prevention research.
  - The outcome in terms of building capacity and adding value through collaborations and networks.

Recommendations for further activity

In the light of the current funding landscape, to make recommendations for what further activity might add value to the NPRI portfolio or advance public health prevention research in the UK over the short to medium term, including:

- Advising the funders on future scientific opportunities, considering future opportunities to build on the NPRI and for novel research in this area.
- Potential activities that would increase knowledge transfer of the NPRI outputs.

3.2. The Scientific Review Group

The evaluation of the NPRI and the future scoping was undertaken by a Scientific Review Group (SRG) chaired by Professor Philip Hannaford (membership below). In addition to the Chair, the group comprised seven researchers with expertise in public health, population health sciences, health economics and behavioural psychology; and three "user experts" with particular interest in knowledge transfer from research into practice or policy. None of the SRG members were principal investigators for any NPRI award. The Medical Research Council provided the secretariat for the Group. Representatives from the NPRI funders observed the SRG meetings.

THE MEMBERSHIP WAS

- Professor Philip Hannaford (Chair) University of Aberdeen
- Professor Linda Bauld, University of Stirling
- Professor Rona Campbell, University of Bristol
- Professor Cam Donaldson, Glasgow Caledonian University
- Professor Susan Jebb, University of Oxford
- Professor Theresa Marteau, University of Cambridge
- Professor James Nazroo, University of Manchester
- Professor Tim Peters, University of Bristol
- Dr Andrew Fraser, * NHS Health Scotland
- Mr Paul Lincoln,* UK Health Forum
- Mr Chris Roberts* Welsh Government

* 'Research user' members

SECRETARIAT

- Mrs Kate Aylett
- Dr Gavin Malloch
- Dr Janet Valentine

3.3. Review timing and process

The NPRI review started in February 2014 and the assessment of the outcomes took place in October 2014 using data captured up to August 2014.

The SRG met three times. At the second meeting, the SRG met in plenary to review all the assessments of the NPRI outputs in terms of the science, influences on policy and practice, and the role of the NPRI in capacity building. The NPRI funders were also interviewed at the time of the second meeting, or shortly afterwards, and the outcome of this was fed into the review at the last meeting of the SRG in April 2015. A workshop to scope future opportunity and priorities in prevention research was held after the second SRG meeting. The outcome of this exercise was a report (Annex 5). This workshop also considered the changing landscape for prevention research. Themes arising from the exercise were further developed and tested through consultation with selected experts, SRG members and NPRI grant holders and funders, before being reviewed at the last SRG meeting.

In between the meetings, group members were designated tasks, including summarising the scientific outputs and their impacts on capacity and skills development. The inputs to these activities included transcripts of interviews held with the NPRI grant holders.

The SRG also established a 'policy and practice' subgroup that met once to consider the impact of the NPRI on public health policy and preventive practice.

3.4. Evidence and analysis

The review of the portfolio of research achieved through the four funding calls was based on (a) funder records of awards and abstracts and (b) coding of the research projects into simple broad categories to explore the range of research objectives, stages, and approaches in the portfolio.

Consideration of outputs and impacts began with compilation of a dataset from Researchfish of self-reported publications linked to NPRI awards, as well as self-reported instances of collaboration, impact, further funding etc. These data were adjusted where, for example, omissions were reported by researchers involved, and to filter out – as far as possible - outputs which had been reported by groups but which did not appear to have a direct relationship to the NPRI project.

Interviews were held with 57[3] of the award holders to provide more insight into the contribution of the NPRI to capacity building, and to seek views of future challenges and opportunities for prevention research. The interview transcripts were also used to gain fuller understanding of the scientific and translational outputs. More detail is provided in Annex 1.

4. Portfolio of projects funded

This chapter looks at what each NPRI call sought to achieve; the questions and approaches (methods, population sectors) of funded projects; and when the research took place. Timing was an important consideration since some of the research funded by the NPRI (from later rounds) was still in progress. The SRG had to be mindful of this when making conclusions based on the outcomes available at the time of the review.

4.1. The four funding calls

The NPRI objectives and funding criteria evolved with each succeeding call for proposals through discussions amongst the NPRI partners. Each call was consistent in seeking research relating to risk reduction and/or health behaviour change. Specifically, these were tobacco use, alcohol misuse, poor diet and/or physical inactivity including their relation to weight management and obesity; all these areas were considered important for the prevention of future disease. The objectives were to be addressed through a variety of approaches, for example, interventions or observational work; and this could involve pilot/feasibility studies.

Each of the call specifications is set out in Annex 2. The first call did not specify a desired approach but the second call was highly specific on seeking to support small projects to analyse existing datasets and look at incentives for behaviour change. Call 3 focused on cross-disciplinary research which developed or tested interventions that were expected to be relevant to practice or policy. Call 4 placed more emphasis on approaches to population-based change.

Figure 1 shows when the NPRI calls were launched, the number of awards made and the financial commitment to each call. Figure 2 shows the timescale over which all the projects from each call were active. It also shows when most projects funded under each call finished in relation to the time of the review; the latter is indicated by a broken vertical yellow line in Figure 2.

For the majority of studies funded in the first three calls (55 projects: 74 percent of projects numerically and 71 percent of the funding committed), it seemed reasonable to assess outputs in mid-2014. This was not the case for projects arising from the fourth phase of funding (19 projects). The first project funded in the fourth call started on 1 March 2012 and only three projects funded under call 4 were due to conclude by the closing date for data capture for the review in August 2014.

There is always a risk when evaluating a research programme before all of the projects are completed and their impact known, in this case counterbalanced by the need to evaluate the programme soon enough to inform decisions about what to do next. As the range of type and topic focus of projects funded in the final call was not fundamentally different from projects funded in the earlier calls, it was considered reasonable to draw conclusions about the NPRI from an assessment of earlier phases.

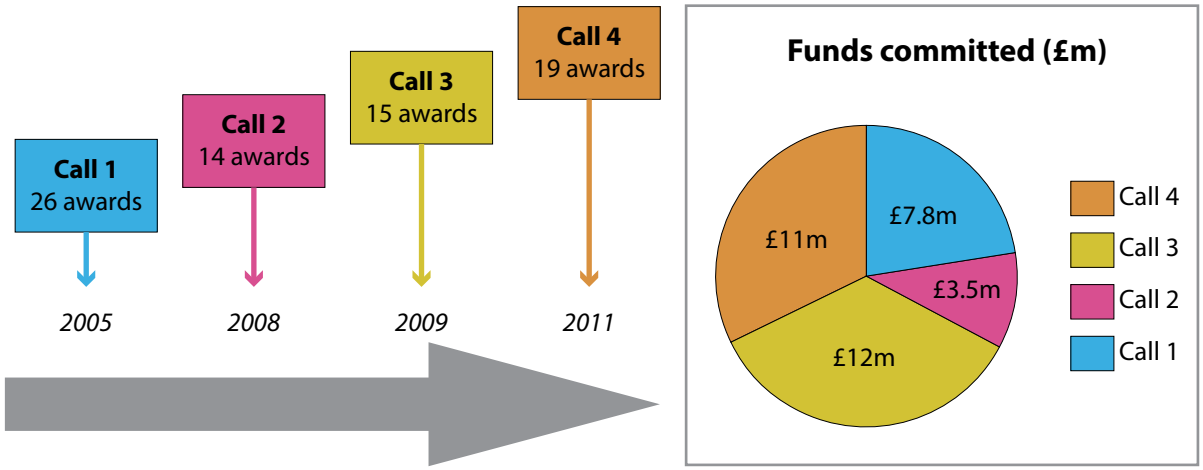

Figure 1: The four funding calls of the NPRI

The years shown are when the awards were made, not when the funding call was agreed, announced or launched.

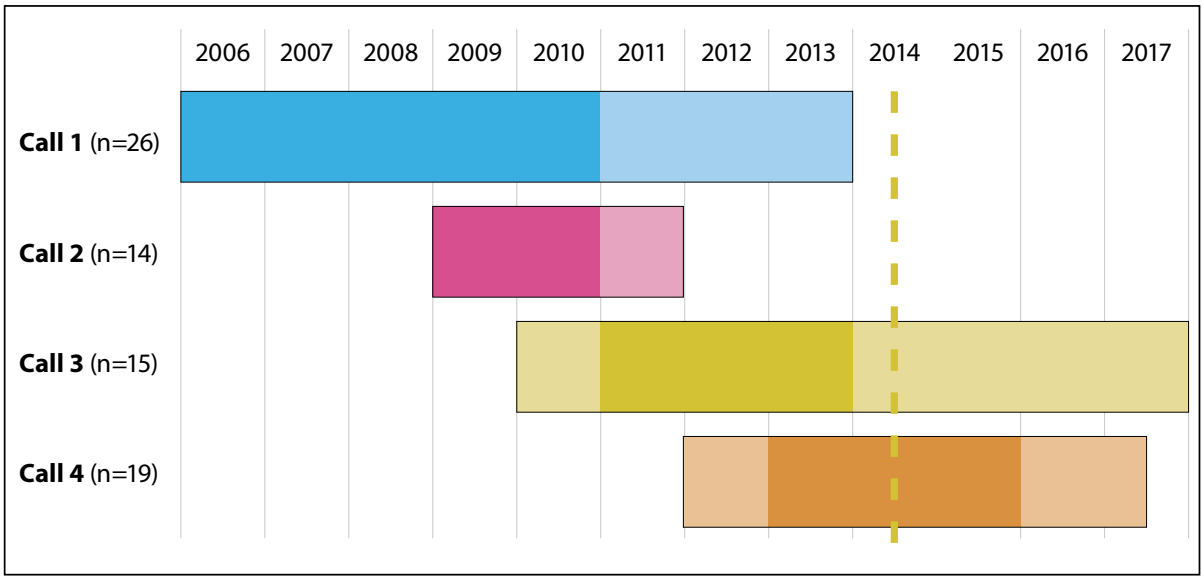

Figure 2: Start and end dates of NPRI grants

Notes for Figure 2: The full extent of the horizontal bars indicates, for each call, the years in which the first project started and the year in which the last project finished. The bolder colour within each bar represents the average project length based on the average start and end date. The long time span for projects in the third call is due to delays in starting some projects. It was anticipated that some projects in call four would be also be delayed due to problems in recruitment of individuals to trials. The yellow dotted line shows approximately when the NPRI review took place. Not shown in the Figure are three projects (each awarded for 1 or 2 years) funded under the fourth call which were due to conclude by the closing date for data capture in August 2014.

4.2. Portfolio breadth – study type, health behaviours and people studied

The portfolio of funded awards encompasses a wide range of different research approaches and stages. As shown in Table 1, the portfolio includes both observational and intervention studies, with overall more intervention studies than observational studies.

If the full portfolio of 74 projects is viewed in terms of investment, rather than the number of awards, the emphasis on intervention studies is more marked, since such studies had an average value of £500,000 compared with £310,000 for observational studies. The average cost of an NPRI study increased by calls 3 and 4, because of larger trials in these later calls.

OVERALL EXPERIMENTAL APPROACH	NUMBER OF STUDIES			
	CALL 1	CALL 2	CALL 3	CALL 4
Interventions	14	2	12	15
Natural Experiments	0	0	1	1
Observational studies	12	12	2	3
Total	**26**	**14**	**15**	**19**

Table 1: Overall experimental approach taken by NPRI-funded investigators per study and NPRI call

Note for Table 1: For this illustration each study was coded for its 'overall experimental approach', that is, whether it was an intervention, observational study or natural experiment. While the majority of studies fell fully into these categories there were also projects that embraced a variety of approaches and this is explored in Figure 3.

The studies in the portfolio were further analyzed (Figure 3a) as some included significant observational work as well as intervention development and evaluation. Individual-level interventions were almost twice as prevalent as 'population-level' interventions. The intervention studies sometimes included several trial stages and the most frequent stage of intervention study was a feasibility or pilot project[4] (n=20). Four intervention studies had a significant qualitative component that was observational.

An attempt was made in the fourth call to encourage more studies that would evaluate population-based interventions, but the number of population-based interventions increased from five in the third call to six in the fourth call.

The SRG noted that there was a slightly higher percentage of unfinished intervention projects[5] compared with finished intervention projects by August 2014; and more intervention projects had finished than observational studies.

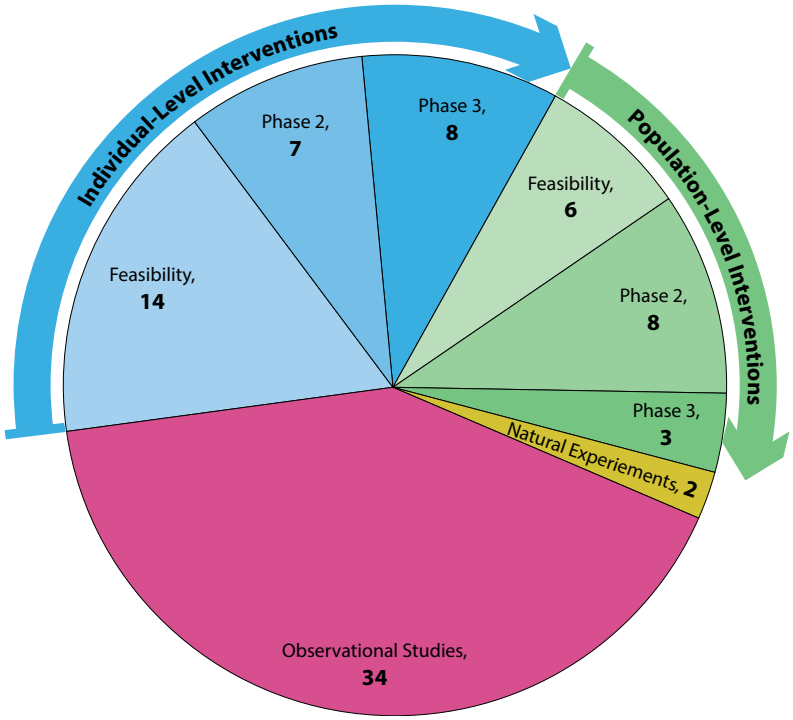

Figure 3a: NPRI research projects – methodological approaches

In the pie-chart, the numbers refer to the number of studies taking the following methodological approaches:
- Interventions at the individual-level (blue wedges)
- Interventions at the population-level (green wedges)
- Observational studies (crimson)
- Natural experiments (yellow ochre)

The shades of blue and green represent phases of intervention development and evaluation, in this case whether the study was assessing feasibility to intervene or whether it was a phase 2 or 3 trial.

Note that
- Population-level trials were defined here as studies where the intervention was delivered simultaneously to more than one individual, usually a large group
- The observational category includes descriptive epidemiological studies seeking to identify risk factors, secondary data analyses (mostly call 2) and economic evaluations.
- Projects could be assigned to more than one category.

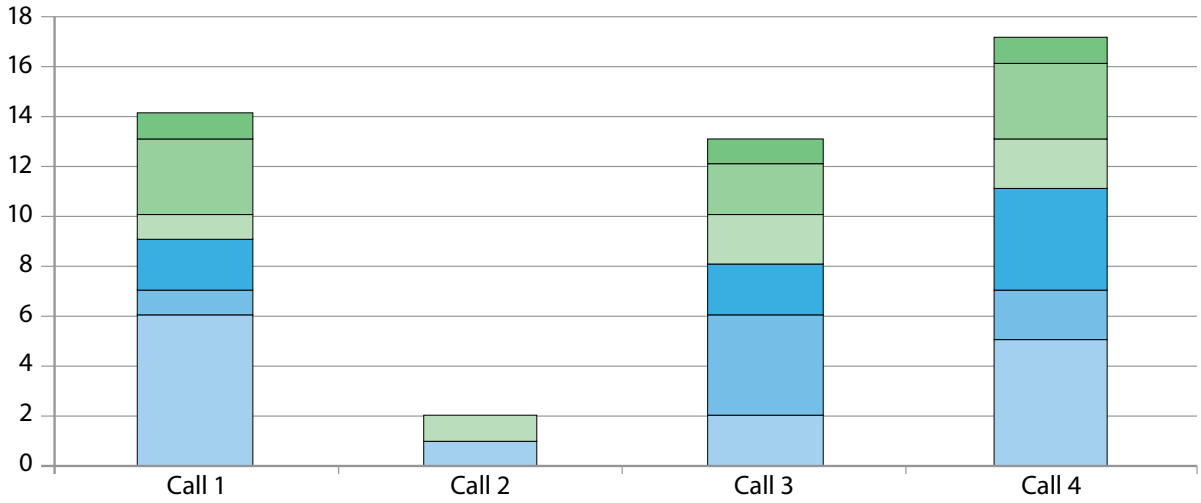

Figure 3b: NPRI intervention research – number of studies in each call by type of intervention and trial phase

Only the intervention studies are shown. Note that projects could be assigned to more than one category so the sum of the values of the bars exceeds the total number of intervention studies. The categories are the same as the intervention studies in figure 3a.

Health behaviours studied

The NPRI was established to reduce the risk of chronic disease arising from tobacco use; alcohol misuse; physical inactivity; and poor diet and nutrition (in particular, but not solely, in relation to weight gain and obesity). The aim was to inform on, or support the development of, strategies to reduce risk, especially in communities or groups with a high incidence of preventable diseases or conditions. The NPRI also set the aim of exploring approaches to reduce inequalities in the incidence of preventable diseases or conditions. Figure 4 shows the number of NPRI projects which addressed the targeted health-determining behaviours. An additional category, 'multiple behaviours', is included for studies that did not specify a single health behaviour. This category included, for example, studies focusing on life course transitions to promote a range of healthy 'lifestyle habits' and studies that assessed the determinants of a wide range of health behaviours - one study simply considered a 'lifestyle intervention'.

The NPRI portfolio included research on each of the behaviours that the NPRI had been established to address. However, perhaps unsurprisingly, there was little or no coverage of other behaviours, such as the use of controlled drugs; violence, high-risk sexual behaviour, environmental hazards such as UV light or poor air quality; or injury.

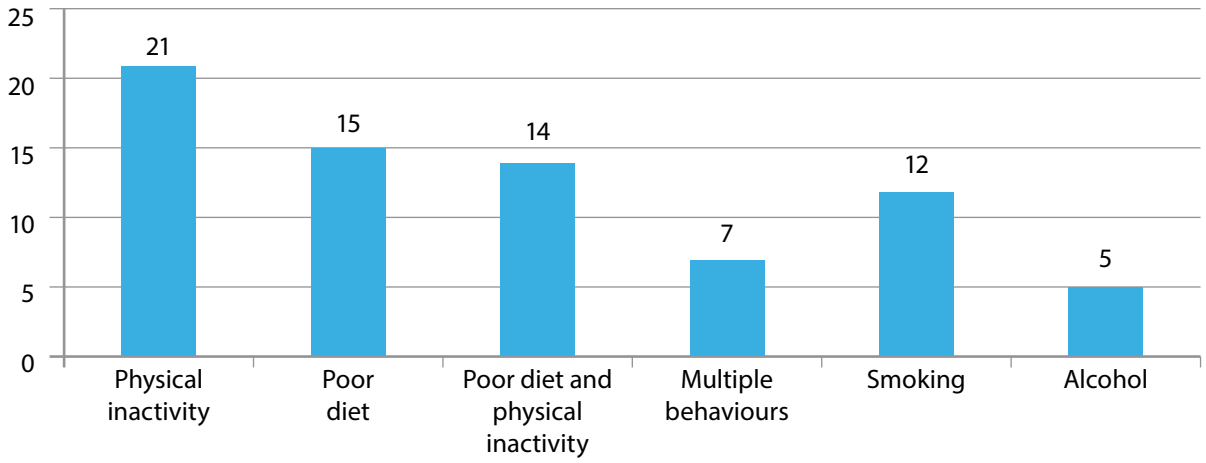

Figure 4: Health behaviours addressed by NPRI studies

Note to Figure 4. Projects were assigned to a single category, so the numbers in the bars add up to 74 (the total number of NPRI studies). Fourteen studies addressed poor diet and physical inactivity together as a composite behaviour, hence the separate category.

The analysis showed that research on poor diet and physical inactivity[6] comprised a major part of the research effort, with 68 percent of the 74 studies addressing these behaviours. This was a feature of the NPRI at the outset; in call 1 poor diet and physical inactivity was reported to have attracted equally large shares of the budget and at a level approximately three times that committed to alcohol misuse. Research on physical activity had not been a strong theme in public health prevention research before the NPRI.

Characteristics of the individuals, populations and settings studied

Where specified, most projects investigated behaviour in individuals representative of the general population. However, around a quarter of NPRI studies focussed on individuals or groups considered to be at elevated risk because of their behaviour (e.g. smokers) or a risk factor (e.g. obesity). Table 2 shows that NPRI research covered most of the life-course, with as many studies focused on adults as on children. When the gender of participants was specified, there was more emphasis on women. Five studies involved women only - one in

pregnant women, one in breast-feeding women, one in mothers, and two in women of African and South East Asian ancestry.

The SRG was surprised by the low level of investment in studies addressing low socioeconomic status (SES), deprivation, or health inequalities, where the need for research is disproportionately high. Just five studies set out to study some aspect of low income, although low SES status was also a component of five studies involving minority ethnicity groups. In addition, two intervention studies carried out secondary analyses to determine whether there was a SES gradient in the effectiveness of the intervention, and seven studies mentioned inequalities in the proposal abstract. There were other studies where research into socioeconomic differences appeared highly relevant but where this aspect had not been developed.

INDIVIDUALS, GROUPS AND SETTINGS STUDIED	NUMBER OF STUDIES
AGE AND GENDER WHERE SPECIFIED	
Children and adolescents	11
Adults	12
of which:	
• Young adults (18 – 34)	3
• Middle age adults (age range not defined)	1
• Older adults (50+)	3
• Women only	5
SELECTED POPULATIONS	
Minority ethnic groups	8
Regional population or members of population cohorts	13
IDENTIFIED RISK FACTOR	
People with chronic disease*	6
Obese individuals	8
Those identified as at high risk of specific disease **	5
SETTING	
General practice/primary care	4
Pharmacy	1
Schools	3
Areas of deprivation***	5
Workplace	3
Supermarkets	2

Table 2: Target group and setting of the NPRI studies

A study could include one or more of the categories listed above. For example, a study looking at smoking in adolescence was counted twice. Thus, the sum of the values in the right hand column exceeds the total number of NPRI projects.

* Includes four studies on mental illness

** Cancer (two studies) and cardiovascular disease (three studies)

*** Relates only to studies that set out to address deprivation – excludes secondary analyses or studies looking at socioeconomic differences unless that was the major aim of the study.

5. Outputs and impacts from the research

For the studies funded from the first three calls, it was reasonable to assess their outputs in mid-2014.

The review concentrated on published work, and its importance and features. This was supplemented with aggregate data on publications, publication patterns and citations. The review also considered the influence of project outcomes on policy and practice. Illustrative case studies are provided in chapter 6, with reference numbers linking to the comprehensive listing of NPRI projects in Annex 3.

5.1. Publications and bibliometrics

For the review, it was possible to use comprehensive Researchfish data (see Annex 1) for the period to October 2013, supplemented by a small number (n=17) of individually reported publications from October 2013 onwards. The total number of publications[7] identified was 318 (Figure 5). The vast majority were from calls 1, 2, and 3 (298 papers from 53 projects); and one-third of all the papers had been published in the final twelve months of data collection (2012 to 2013). The SRG considered the total volume of publications to be reasonable. Some groups appeared to be attributing some papers arising from work funded by other agencies to their NPRI grant. Even so, and after the removal of two outliers, there was an average of nearly five (4.6) papers per award from calls 1, 2, and 3.

As might be expected, publications from the awards were still emerging and a further analysis of publications should be made when papers from the fourth call have peaked.

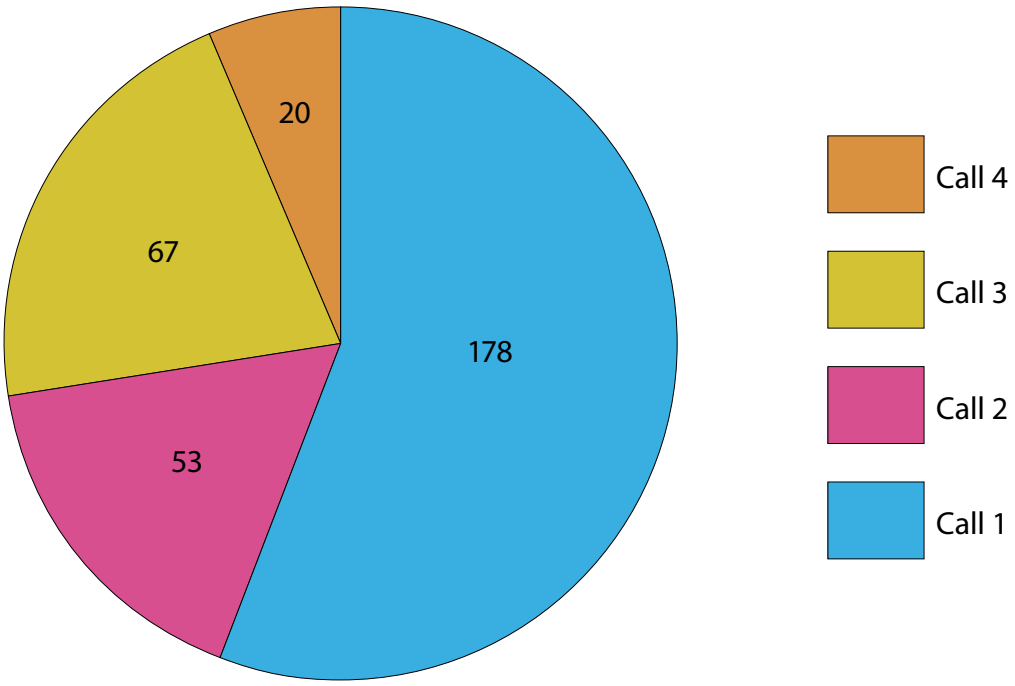

Figure 5: Number of publications by NPRI call.

NPRI grant holders had published in a wide range of journals covering both public health and clinical medicine. A few publications had appeared in high profile journals but the journals most frequently used to disseminate NPRI-funded work were specialist public health or clinical journals. While publication in journals with high impact factors is not necessarily a good measure of scientific, clinical or public health significance, the SRG had expected to see more NPRI-funded research published in such journals. Overall, however, the publication profile reflected the broad public health nature of the NPRI.

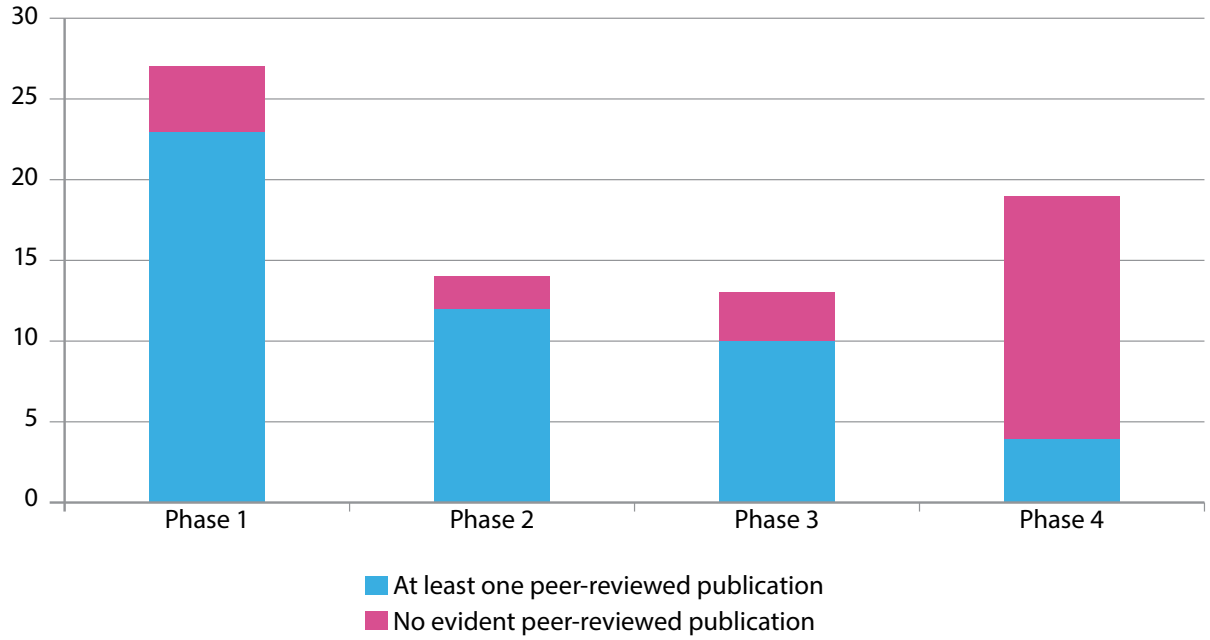

Figure 6: Number of projects reporting at least one or no publication

As can be seen from Figure 6, nine studies funded in the first three calls, with completion dates ranging from June 2007 to just before the review, had yet to publish any peer reviewed paper. The SRG was aware that one of these studies was about to report major findings. This meant that there were eight projects for which no reported outcomes could be detected[8]. The reason for non-publication (when known) included the hoped-for outcome had not been achieved i.e. an association could not be established or the intervention had no effect. Others reasons included practical problems with the study, such as low recruitment affecting the ability of the study to report an outcome in an academic journal. The SRG was disappointed to see this absence of publication, especially regarding negative results or 'lessons learned'. The need for reporting should be emphasised in future funding calls and systems put in place to manage this more actively. Several NPRI projects had published negative findings and qualitative accounts of project challenges which were valuable contributions to knowledge.

The SRG looked to see if there was early evidence of impactful scientific publications emerging. Based on the available citation data for 194 papers published before October 2012, 95 reported in *Researchfish* had achieved Journal NCI[9] scores of more than 2, and 31 had achieved NCI scores of at least 4 (see Annex 4). It was estimated that around half of these publications were reporting outcomes that were directly relevant to the NPRI-funded research while the other half had been outcomes from work funded by other sources where the contribution of the NPRI grant was more difficult to assess but where there was likely to have been an 'NPRI contribution'. It was also noted that three times as many of the early cited papers were from observational studies as from intervention studies. Although it was too early to make a detailed assessment of citations arising from NPRI-related publications it was noted that a number of studies had already resulted in publications with a high citation rate.

5.2. Scientific outcomes, a qualitative view

In this section the numbers in square brackets refer to the project numbers listed in Annex 3. Selected case studies are provided in Chapter 6 to illustrate the diversity, relevance and impact of some of the work.

Looking at the key outputs from 34 of the 49 studies with a published output, it is clear that most (approximately 85 percent) addressed most or all of the aims set out in the original proposal. There were cases where it was harder to say whether all of the objectives had been met and some of the available or PI-identified key publication(s) covered only one of several aims that had been set out. In some cases the reported outcome of a study was still awaited. The SRG noted that across the portfolio the level of contribution of individual projects to knowledge was variable. A number of studies had made major innovative advances (as highlighted below and in section 5.4) to knowledge. Many others had made important but more incremental contributions to knowledge addressing major public health issues.

The SRG noted some important methodological contributions, particularly regarding advances in the use of digital/mobile technology for independent data collection, for example a smartphone app [study 44: *Professor Janet Cade, Smart phone: promoting weight loss and improved health using mobile phone technology*] for recording behaviour as well as providing advice on healthy behaviour. Project number 8 [*Dr Ashley Cooper, Environmental determinants of physical activity and obesity in adolescents*] shows how objective measurement of physical activity patterns and environmental and social determinants can be measured in young adolescents during an important transition in their life - the period between the last year of primary school and the first year of secondary school. The published papers provided information for targeted activity promotion in this group which was considered to be at higher risk for a decline in physical activity.

The innovative use of data was another feature of NPRI work. For example, one study [48: *Professor Martin Gulliford, Role of primary care in translating effective lifestyle modification strategies*] demonstrated that it is possible to undertake health economic modelling using electronic general practice-based health records. Another project [32: *Professor Sarah Lewis, A comprehensive evaluation of the impact of English tobacco control policy on smoking cessation activities*] showed that GP data combined with other databases provides a reasonably valid source of information on smoking rates, at both national and regional level; possibly providing an alternative source of such information than more costly endeavours such as national household surveys. One study [51: *Professor Frank Kee, Physical Activity and the regeneration of Connswater (the PARC study)*] was still in progress at the time of the review but had already provided important findings about how shifts in context may increase uptake of physical activity opportunities without any added benefit from financial incentives. Another study [74: *Professor Sarah Lewis, The effectiveness of mass media campaigns in reducing smoking, second-hand smoke exposure and smoking-related disease in England and Wales*] had combined existing sources of data to comprehensively evaluate the success of various tobacco reduction policies and provided an important analysis of the reliability of smoking prevalence data.

The intervention studies had also made some important advances. For example, one intervention study [*41: Professor Annie Anderson, BeWEL the impact of a BodyWEight and physical activity intervention on adults at risk of developing colorectal adenomas*] had used routine health screening of those identified at risk of cancer to promote weight loss with a standard intervention. A study of ethnic South Asian families in Scotland [5: *Professor Raj Bhopal, A family based trial for primary prevention of type 2 diabetes in South Asians (RCT)*] showed for the first time that an intervention in this community could lead to a modest, but clinically important, reduction in weight, resulting in a lowered risk of type 2 diabetes.

The SRG highlighted the importance of researchers publishing their experiences of undertaking public health prevention research, including its perceived value, the effect of context, and methodological and practical challenges. One publication, from study [72: *Dr Rajalakshmi Lakshman, Establishing a healthy growth trajectory from birth: The Baby Milk Trial*], had included a useful critical reflection of the challenges and benefits of applying the

MRC framework for the development and evaluation of complex interventions to the development of a public health intervention; in this case to avoid excess formula-milk intake and associated rapid weight gain during infancy. Another study [67: *Dr Kamran Siddiqi, 'Muslim Communities Learning About Second-hand Smoking - MCLASS Study*] had worked with faith leaders and families attending mosques to try and reduce the exposure of children to second hand smoke. This study gave a valuable account about how to introduce a public health intervention in this setting. The SRG welcomed these contributions.

5.3. Scientific gaps and opportunities for added value

The SRG noted that some studies had missed the opportunity to gain additional scientific value to the work, possibly due to insufficient time or funding. For example, intervention studies rarely explored the mechanism(s) of action for interventions. In some observational studies, behavioural data to inform a future intervention study would have added value, as would have mechanistic data to explain why observed changes might be occurring. Another missed opportunity was the fuller exploration of the wider components, beyond the perceived active ingredients, of the intervention that might achieve or enhance a behaviour change, or have implications for the way the intervention was delivered or when it was applied. The SRG highlighted study [3] where such potential existed but the funding format did not allow the opportunity to be taken[10].

With respect to scientific coverage, the SRG noted that the NPRI had not highlighted mental health as an important area of research, and as a consequence this represented an important gap in the portfolio. Dementia, now recognised to be a condition with modifiable risk factors, was another important deficit.

5.4. Verified influences on policy and practice

The NPRI did not initially set out to fund research that had to be policy-relevant. This objective is mentioned in call 2 and is explicit in calls 3 and 4. Nonetheless, it was recognised that contributions to policy and practice were an important impact and should be expected from applied public health prevention projects funded under all the calls.

Many NPRI grant holders had made some attempt to engage with policy-makers and/or health practitioners and end-users. Section 7.2 deals with this broader collaborative work. Here we describe those projects that, in the view of the SRG, had a verifiable impact on policy or practice; or had provided evidence to inform policy or practice change which had not happened yet. To this end, self-reported influences on policy and practice from 55 projects in the first three calls, and one from the fourth call, were assessed by a subgroup of the SRG. The reports in Researchfish were supplemented by information obtained during the interviews. The policy subgroup, using their own knowledge and policy and practice networks, verified the contributions that each NPRI project claimed in shaping policy and practice. The subgroup also assessed the reach, potential and importance of the impacts.

There were 13 studies with verifiable impacts and another one which had evidence to inform future policy although the findings had not yet been taken forward by policy-makers. Twelve of the impacts arose from studies funded from the first three calls. Some of the impacts are highlighted in case studies in Chapter 6.

The SRG noted that the policy impact of NPRI projects appeared to be strongly correlated with PIs who were active in disseminating their work beyond publication in academic journals. Many of these PIs were, or had become, well embedded in policy and practice networks and were familiar with the co-production of knowledge. This was particularly evident in study [51], where there was continuous engagement of policy-

makers in the study with cross membership of groups and constant two-way scientific and policy advice in developing strategy for Northern Ireland.

Partnerships with third sector and other advocacy organisations had sometimes helped with the translation of findings into policy and practice, but had not been widely used. Some investigators appeared not to have followed-up on the policy or practice implications of their work and had either been unclear about how to progress this or did not perceive this to be part of their role. Indeed, some stated that engagement with policy stakeholders was too difficult or time consuming. The SRG felt that the message about the benefits of working more closely with policy-makers and end-users should be reinforced. Looking to the future the SRG suggested that the funders consider ways of encouraging and supporting public health prevention researchers to build networks with end-users, at the design as well as other stages of the research.

The SRG noted that only three intervention studies had influenced policy and practice by the time of the review. The number was too small to make definitive statements and the SRG recognised that there were several intervention studies still in progress. In addition, many of the intervention studies in the NPRI portfolio were pilot/feasibility studies and so unlikely to impact on policy. It was also noted that the studies that had influenced policy or practice were not always associated with high impact academic publications (when measured by number of citations or impact factor of the journal in which the outcome was published). Indeed one study [33] had not led to any academic publication at the time of the review although it had already influenced national policy.

The SRG highlighted how policy change takes time and rarely arises from the outcome of one study. NPRI projects were usually researcher-led and not systematically co-produced. Expectation of policy impact was not established at the outset. Given this context, the SRG regarded the figure of 12 out of 55 projects (22 per cent of all projects in the first three calls) with significant impact or influence on policy or practice as good, especially given the relatively young maturity of the portfolio.

6. NPRI case studies

A selection of studies is showcased in this chapter to illustrate the diversity of NPRI studies and their impacts. Each case is preceded by the name of the PI and her/his title, abbreviated name of her/his institution at the time of the award, and the title of the project[11].

Study [44]:

PROFESSOR JANET CADE, UNIVERSITY OF LEEDS: SMART PHONE: PROMOTING WEIGHT LOSS AND IMPROVED HEALTH USING MOBILE PHONE TECHNOLOGY

The objectives of this study were to develop a mobile smartphone package to support weight loss. The smartphone app (*My Meal Mate*) was the first free app to contain a large UK-based food database. When tested in a small trial against other products (a website and paper diary), for self-monitoring of food intake, the app was used two to three times more often than the other products (which were only used about once a week). The results found that over the six months of the study, those using the app lost more weight. The app has also proved to be one of the most effective methods for tracking food intake and calories to support weight loss and was the first such app to be hosted on the NHS Choices website, where it is frequently downloaded (the apps had received between 10,000 and 50,000 downloads as at May 2014)[12]. The app has also been cited in NICE guidance.

Study [8]:

DR ASHLEY COOPER, BRISTOL UNIVERSITY: ENVIRONMENTAL DETERMINANTS OF PHYSICAL ACTIVITY AND OBESITY IN ADOLESCENTS

The project developed an objective way to measure the spatial location of physical activity by combining accelerometer data with that from personal GPS receivers to see where children go to be physically active. A main purpose of the study was to explore changes in physical activity across the primary/secondary school transition and to identify factors potentially influencing the decline in physical activity through adolescence. No overall difference in physical activity was seen in children measured in primary school and one year later in secondary school. However, among children with longer distances to travel to and from school, physical activity declined markedly in those who changed from walking to motorised travel and increased in those who continued to walk. The study outcomes were published in the journal *Medicine and Science in Sport and Exercise*.

Study [45]:

PROFESSOR SIMON CAPEWELL, UNIVERSITY OF LIVERPOOL: PREVENTION IMPACT: DEVELOPING AND EVALUATING ECONOMIC MODELS FOR PLANNING OPTIMAL CARDIOVASCULAR PREVENTION STRATEGIES

Professor Capewell and colleagues developed a model for heart disease, called IMPACT, in relation to prevention policies that estimated deaths prevented or postponed, life-years gained, and the cost-effectiveness of different interventions. The consistent findings were that cardiovascular mortality is decreased more by population-wide improvements in major risk factors than by medications or surgery. Furthermore, the rise in obesity and diabetes in the UK has generated additional deaths in the UK. Studies built on the foundations of the NPRI project have led to some high impact papers from this group[13].

Study [2]:

DR ASHLEY ADAMSON, NEWCASTLE UNIVERSITY: EARLY ORIGINS OF OBESITY: DEVELOPING STRATEGIES FOR INTERVENTION

This project sought to determine the early origins of obesity in 619 children that were between six and eight years old at the time of the research. A quarter of the children were overweight or obese, as were half of their mothers. Only 7% of the children were meeting recommended physical activity targets and they also ate (on average) 1.7 portions of fruit and vegetables per day (3.3 portions less than UK recommendations). Parents overestimated how active their children were and thought that the scale of the problem of childhood obesity was 'overhyped'. In addition to some highly-cited scientific papers, the project also had significant coverage in the media and was cited in the Health Survey for England 2008 '*Physical activity and fitness*'[14] and the National Obesity Observatory report '*Physical activity surveillance in England: what is measured and where are the gaps?*'[15] (both published in 2009).

Study [25]:

PROFESSOR ROBERT WEST, UNIVERSITY COLLEGE LONDON: THE EFFECT OF TABEX (CYTISINE) ON ATTEMPTS TO STOP SMOKING (RCT)

Professor West conducted a trial to see if a very low-cost smoking prevention therapy called cytisine (marketed as Tabex) could be effective in helping people stop smoking. Smoking cessation medicines in developed countries such as the UK are quite expensive and the market is dominated by (relatively) new products developed by large businesses. Tabex has been used in Eastern Europe for the past 40 years but had not been adopted elsewhere because of insufficient evidence on its effectiveness. The trial showed that Tabex is a highly effective means of supporting smoking cessation, with participants more than trebling the chances of users quitting compared to those taking a placebo.

This study has led to renewed interest in the drug and in 2014 a study on Tabex's effectiveness in comparison with nicotine-replacement therapy (NRT) was conducted by researchers in Auckland, New Zealand. This study

showed that it was more effective than nicotine replacement therapy (presently the most widely used smoking cessation therapy).

Moves are now under way to license the drug in Europe, the US and many other countries globally, which would make affordable cessation treatments accessible to smokers in most countries of the world.

Study [10]:

PROFESSOR KEN FOX, BRISTOL UNIVERSITY: PROFILES OF PHYSICAL ACTIVITY IN OLDER ADULTS

We previously knew very little about the patterns of physical activity in older people. This research combined expertise in human geography, neighbourhood sociology, health psychology and exercise physiology to document physical activity patterns and the environmental and social determinants of physical activity in urban dwelling older people. In a sample of 125 males (mean age 77.5 yrs.) and 115 females (mean age 78.6 yrs.), physical activity levels were very low and only 3 participants met UK recommendations of sustained bouts of activity for at least 10 minutes. Lower levels of physical activity were found in areas of higher deprivation, correlating with poor physical function, higher body mass index, and lower frequency of journeys away from the home. Observations from the project have been used to inform a practical guide for developing interventions for physical activity in older people and this had been published on the Age Action Alliance website[16]. These were the first guidelines worldwide on physical activity specifically for older adults. Professor Fox also co-authored a chapter in the Chief Medical Officers' (CMO) report on physical activity, based on these results[17].

Study [33]:

PROFESSOR LAURENCE MOORE, CARDIFF UNIVERSITY: FREE SCHOOL BREAKFAST INITIATIVE; DATA AUGMENTATION AND ANALYSIS

This NPRI award supported a secondary analysis of data that had been generated by a trial of primary school free breakfast provision commissioned by the Welsh Government. The NPRI-supported analysis showed that universal school breakfast provision may reduce health inequalities because the trial led to an increase in healthy eating and reduction in breakfast skipping among children from lower socio-economic status groups in particular[18]. This has influenced on-going national policy discussions, with the work being drawn to the attention of Ministers as an exemplar of research evidence informing practice. It has been widely cited in evidence seminars, often with senior policy officials, as well as researchers and practitioners.

Study [28]:

DR LUCY COOKE, UNIVERSITY COLLEGE OF LONDON: THE INFLUENCE OF INCENTIVES ON CHILDREN'S CONSUMPTION OF VEGETABLES

On average, children consume too much saturated fat and sugars and only half the quantity of fruit and vegetables recommended for good health. Parents employ various strategies to encourage their children to 'eat their greens', but the research evidence suggests that many are ineffective and some counter-productive. This study investigated the impact of incentives on liking and consumption of vegetables in 4-6 year-old children in a school setting and also when carried out by parents in the home. The study (now called 'Tiny Tastes') provided independent evidence to support the use of repeated taste exposure together with small non-food rewards to increase vegetable acceptance in children.

Tiny Tastes has been influential in providing independent evidence to support and endorse a common practice adopted in the Department of Health's Start4Life Campaign. The researchers have worked hard to disseminate the study outcome. It is now widely known and used by many parents.

Study [42]:

PROFESSOR PAUL AVEYARD, UNIVERSITY OF BIRMINGHAM: TESTING THE FEASIBILITY OF NICOTINE ASSISTED REDUCTION TO STOP IN PHARMACIES. THE REDPHARM STUDY

Researchers from the University of Birmingham carried out a feasibility study to examine whether community pharmacists could be trained to deliver nicotine-assisted reduction to stop (NARS) interventions to people to cut down on smoking. The NPRI study showed that promoting this in routine practice was not well received by pharmacists and not many patients took up the offer of support and medication. As the PI was a member of a NICE Tobacco Harm Reduction guideline group[19] the guidance did not encourage pharmacists to provide smoking reduction services. The study showed how a 'negative' result can be policy relevant.

During the study, some people did reduce their smoking. Furthermore there was evidence that a schedule to help people reduce smoking was more effective than simply trying to reduce smoking without a schedule. This was subsequently cited by the NICE review. The PI has refined the measures used as part of the NPRI-funded research and made them available on a website for download.

Study [13]:

PROFESSOR GERARD HASTINGS, STIRLING UNIVERSITY: ASSESSING THE CUMULATIVE IMPACT OF ALCOHOL MARKETING COMMUNICATIONS ON YOUTH DRINKING

This project aimed to examine the relationship between alcohol marketing and alcohol consumption in the young; specifically, whether advertising encourages drinking in young teenagers (13 to 15 years old). The research also included a systematic review of studies of alcohol marketing. The NPRI project contributed to a body of evidence that teenagers are influenced by marketing and as a result drink more, from a younger age. The research showed covert associations between alcohol and social and sexual success, as well as with attractive lifestyles. These findings contributed to the House of Lords Health Select Committee on Alcohol Harms[20] and were cited in '*Health First*' - the independent alcohol strategy for the UK published in March 2013[21]. While recognising that the influence of the NPRI project was partly due to Professor Hasting's extensive work over a number of decades, there was clear evidence that the NPRI project itself contributed to alcohol policy and strategy development.

7. Impact for funders and researchers

Beyond the results achieved through individual awards, the value of the funding model was assessed through interviews with funders and award holders.

7.1. Funding partnership and funding policies; impact and lessons learned

The NPRI raised the profile of both funders and the recipients of awards. Almost all of the 15 funders[22] interviewed considered that there had been some value in participating in the initiative, beyond that which could have been achieved individually. Examples of benefits included the high profile that the NPRI achieved, the large, competitive pool of applications and the ability to cross traditional remit boundaries. The NPRI was seen to be a good exemplar of funders – some with very specific remits and missions - working together for many years to address diseases and conditions with common risk factors. The initiative had enabled several funders to be involved in supporting research which they would not normally have considered to be within their funding remit, such as projects concerning the environment and urban infrastructure. Some of the smaller funders welcomed the opportunity to contribute to an important area that they had not previously prioritised due to the cost of the research needed to make an impact.

During the interviews, the credibility of researchers funded by the NPRI was reported to be a factor in establishing new collaborations. This helped pull in expertise, sometimes from abroad, as well as helping networking with practitioners and policy-makers. It was also reported that multiple-agency funding had raised the profile of public health prevention research and that this had influenced subsequent initiatives in public health. Furthermore, a common comment was that the NPRI provided an opportunity to support public health prevention research at a time when it was considered difficult to find a 'natural funder' for such work, particularly when a specific disease end-point was not apparent. Sixteen of the grant holders held the view that funding for studies of the type supported by the NPRI would not have been possible without the initiative. Although there is now a range of funding opportunities for research in non-communicable diseases, the NPRI was seen to be the forerunner.

By the time of the review there were several other examples of funders working together on prevention sometimes in challenging areas. For example, in recent times, there has been a change in the recognition of dementia as a condition with modifiable risk factors and increased research funding into the condition. Public Health England has adopted dementia as one of the major challenges for public health, resulting in further collaborative working. Joint work between funders in the NPRI, including with the Alzheimer's Society and Alzheimer's Research UK, will have helped change the funding landscape of this disease. Such collaborations may well not have occurred without the experience gained through the NPRI.

While the NPRI model was a good way for funders to share a common goal, the NPRI functioned mainly as a grant scheme for public health prevention research, with the NPRI PRAB[23] defining each call and the academic community responding. At the time of the first call there had been no expectation of a second call, let alone four, so the NPRI developed organically. There was no strategy for proactively engaging with users or for pre-ordained knowledge transfer; and measures taken to shape applications (in terms of focus, methods or quality) were relatively light touch.

The initiative was also broad in scope, open to all researchers (rather than only those based in centres of excellence or through programmes of work). This led, perhaps, to fewer connections with end-users and reduced potential for impact in discrete areas. However, from the start, the initiative provided an important funding opportunity when few other options existed, and it fostered the development of capacity in public health prevention research. Furthermore, the approach developed during the four rounds of funding, provided valuable insights into how future prevention research might be shaped and directed, including the need to enhance knowledge exchange into policy and practice. Overall, the benefits of the funding model appeared to exceed the limitations.

7.2. Strengthening the research base

A key aim of the funding partners when supporting the NPRI was to strengthen capacity for public health prevention research. The research base in the UK has undoubtedly strengthened over the last decade. While it is not possible to attribute this improvement entirely to one single initiative, the NPRI was judged to be an important contributor to the strengthening. The review looked at three specific indicators of capacity development:

- self-reported impact on careers and training
- frequency and type of further funding achieved
- patterns of collaboration

Careers and training

In the interviews, 45 of the 57 grant holders (79 percent) reported that the NPRI award had helped them acquire skills and qualifications, or had led to other personal development impacts. Noteworthy highlights were:

- Eighteen of the 57 project leaders interviewed (32 percent) reported that the NPRI award enabled them to lever funding for a PhD student.
- NPRI funding was the first substantial grant of several PIs, who subsequently benefited from a significant improvement in their profile. Sixteen of the 57 grant holders (28 percent) who now hold senior positions within their institution said that their career started with the NPRI award; with one saying that his promotion to professor was a direct result of the outputs and impacts from his NPRI award.
- Another 28 percent of grant holders reported that the NPRI funding provided the opportunity to retain key staff in public health prevention research; staff retention having been a particular issue for prevention research when the NPRI started.

On the negative side, 18 grant holders reported that they had been unable to find a suitable candidate for a vacancy requiring a specialist skill. Health economics was the most commonly cited discipline experiencing recruitment difficulties.

Further funding

The review explored whether the NPRI awards had led to further funding for follow-up or 'aligned' projects. As many of the NPRI studies were pilot studies or trials, (see Chapter 4), follow-on funding would indicate another element of the NPRI seeding further public health prevention research.

The total value of additional funding was estimated to be £17m[24]. This value means that almost 50 pence has been generated for new work, for every pound invested via the NPRI; with further increases likely as the fourth round of projects comes to completion. Figure 7 shows the source of additional funding. A key source by financial value has been the National Institute for Health Research (NIHR), which was responsible for 49 percent additional funding. Further funding was mostly for aligned projects, where outputs emerging from on-going NPRI-supported research had helped to make the case for further funding. There were three follow-on funding projects supported by the NIHR Public Health Research Programme (PHRP) which specifically arose from NPRI-funded pilot studies; this number could increase as awards from the fourth call are completed.

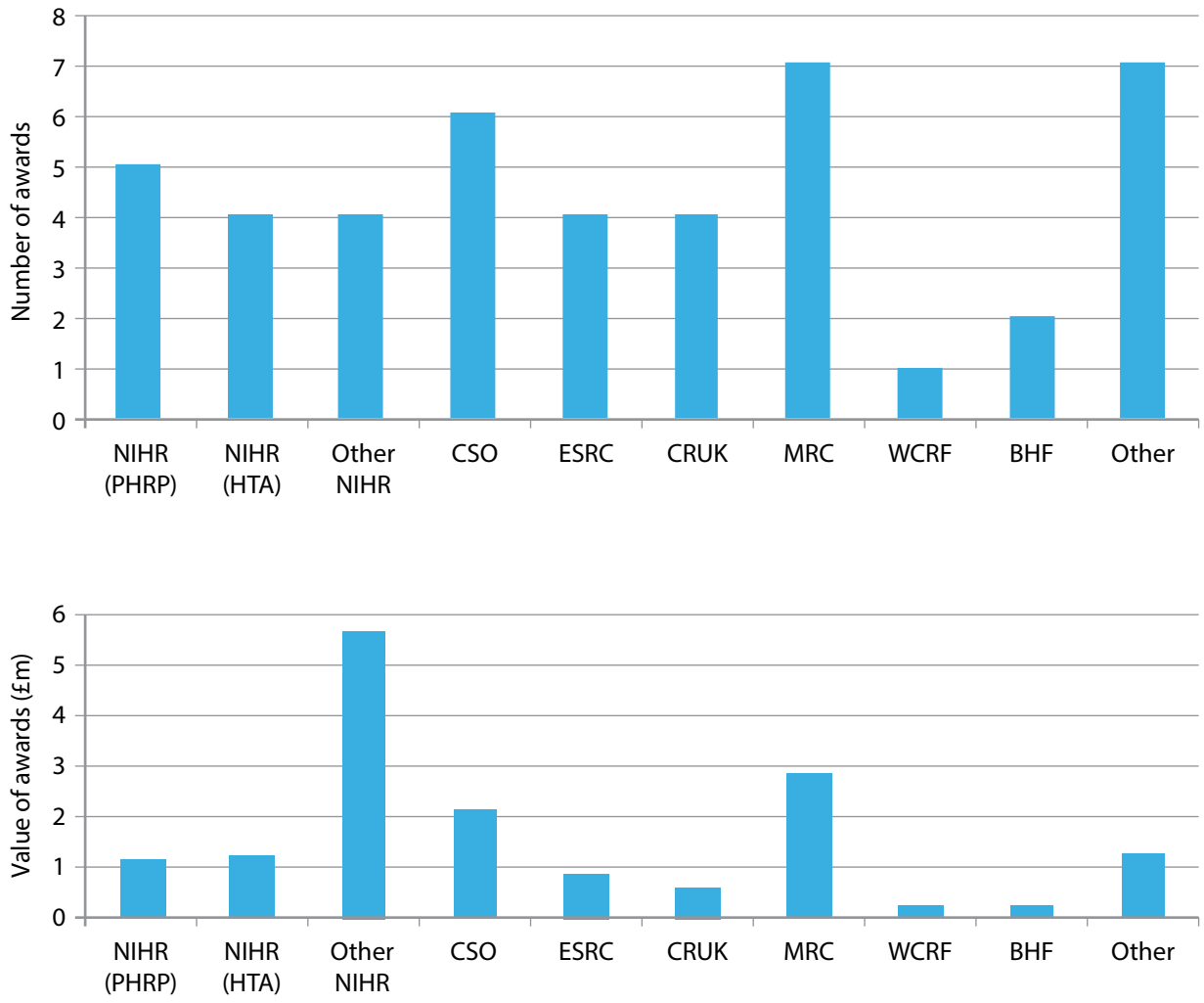

Figure 7: Further funding by source: number of awards (top panel) and value (bottom panel)

Note for Figure 7. In the upper panel the bars represent the number of follow or, or aligned grants, awarded by each funder. In the lower panel, the bars represent the total value in £m from each funder.

Key: NIHR (PHRP) – NIHR Public Health Research Programme, NIHR (HTA) - NIHR Health Technology Assessment, Other NIHR – Research for Patient Benefit scheme but also one award from the Health Services and Delivery Research (HS&DR) Programme, CSO – Chief Scientists Office (Scotland) NIHR (HTA) - Health Technology Assessment, ESRC – Economic and Social Research Council, CRUK- Cancer Research UK, MRC – Medical Research Council, WCRF – World Cancer Research Fund, BHF – British Heart Foundation

Collaboration

The NPRI was highly collaborative from the outset; 74 funded projects involved 330 PIs and co-applicants from 60 institutions. Sixty percent of the award holders reported at least one further collaboration (139 collaborations in total). As shown in Table 3, most of the collaborative links were with other academics. In the interviews, many of the NPRI grant holders reported how the NPRI project had catalysed collaborations with those working in other disciplines who might not have traditionally contributed to public health prevention research, such as transport engineers and geographers. Such linkages were now seen to be more commonplace.

SECTOR	NUMBER OF PRE-EXISTING COLLABORATIONS	NUMBER OF NEW COLLABORATIONS	TOTAL NUMBER OF COLLABORATIONS
Academic	20	60	80
Third sector	0	7	7
Company	0	16	16
Government/public sector[25]	10	15	25
Health sector	0	11	11
Total	**30**	**109**	**139**

Table 3: New and existing collaborations by sector
Source: Researchfish

Holders of 43 awards reported having interactions with policy-makers or practitioners through a number of activities and 35 reported having engaged with research users (not shown in Table 3). From the interviews, the most frequent type of engagement reported included presentations to regional directors of public health and meetings with regulators. For those whose research related to physical inactivity, discussions with Sustrans were commonplace. Further detail on the interviews is available at Annex 1.

Ten of the grant holders highlighted the link between the NPRI and the UK Society for Behavioural Medicine (UKSBM) as being very useful for the development of connections with other NPRI-funded PIs. The NPRI meetings at the annual UKSBM conference have succeeded in bringing people together, to discuss new and existing research areas and generate new ideas for future work. Such activity had generated at least one published paper as well as stimulated future applications for funding. It was suggested that the value of this meeting would be reinforced if it also included an opportunity for NPRI researchers to interact with policy-makers. The UKSBM conference could also provide an opportunity for policymakers (and other interested parties) to gain an overview of a number of NPRI projects at a single event.

8. Future opportunities in research and knowledge exchange

A workshop was held in October 2014 (details in Annex 5) to consider future opportunities in public health prevention research. At its last meeting in April 2015, the SRG evaluated the workshop suggestions in the light of commentary from some key opinion leaders[26] and the SRG's own retrospective look at the NPRI outcomes. The SRG then drew up areas to take forward, which are outlined in Sections 8.1 to 8.3. The Group also reinforced the added value of knowledge exchange to research and policy/practice implementation (Section 8.4).

8.1. Improving interventions to change health-related behaviours

Intervention development

There is opportunity for research to increase the efficacy and effectiveness of preventive interventions to change health-related behaviours. Enhanced development and piloting work, and greater consideration of practical issues related to implementation, could result in stronger interventions that might be easier to evaluate and reproduce. Some enhancements to current practice were suggested:

- Incorporate both theory and knowledge about the mechanisms by which interventions might work into the intervention development process. This could be used, for example, to enhance synergy between effective components of an intervention, or to identify redundancy in existing complex interventions so that costs could be saved.
- Use imaginative trial designs to achieve greater value from evaluations or reduce costs – for example, by identifying groups within target populations where an individual-level intervention may be more efficacious (and which may be masked when assessing the larger, more heterogeneous group of all treated individuals).
- Support researcher/practitioner teams to enable them to engage in cycles of development and testing of interventions, using knowledge from implementation science and process evaluation. This might consider, for example, the role of professional behaviour, the delivery vector, and social and environmental context. The SRG supported the notion of 'realist evaluation' designs[27] which are also important for addressing complexity (see Section 8.2.).

Balance across intervention areas

The NPRI programme had a strong emphasis on interventions at the level of individuals and their behaviour. The SRG's view was that future programmes should have greater focus on developing interventions that may act at other levels or at more than one level, for example, group, community, or population-level. For some issues (such as alcohol misuse), interventions affecting large populations – such as pricing or marketing – may achieve more, at lower cost, than individual based interventions; for other issues (such as diabetes prevention)

it may be important to combine interventions aimed at individuals with population-based interventions, so that each reinforces the other.

Finally, the SRG suggested that funders specifically consider how to promote high quality prevention research to redress health inequalities, health disparities among minority ethnic groups, and mental health and wellbeing problems. These areas were either specifically excluded from NPRI funding (e.g. factors affecting mental health), or were not often addressed in the proposals funded. Quite apart from their importance for health, a broader portfolio of research encompassing mental wellbeing alongside other themes is likely to lead to a more complete understanding of the opportunities for prevention.

8.2. Understanding complexity in public health interventions and evaluations

There is an important opportunity to progress prevention through research that maps the full complexity of the multifactorial determinants of public health. Most intervention approaches do not address all the risk factors for a particular health problem. They also tend to assume that the relationship between an identified risk factor or behaviour and outcome is linear and constant over time, when in reality the interplay between determining factors is dynamic, often changing rapidly, especially in certain environments such as towns and cities. Different factors may also work in opposite directions. Better understanding of the complexity between factors determining health will assist with the identification of novel interventions and points at which maximum benefit may be derived.

This research area is challenging but might be helped through the greater use of large scale individual-based and population-based datasets, asset maps[28], and the use of newer techniques for objective monitoring (for example through the use of digital and mobile technology). New ways of gathering and using large-scale datasets may lead to faster identification of emerging public health challenges, and rapid implementation and subsequent monitoring of effective interventions.

During the consultation with key opinion leaders, views on 'research on complexity' were mixed. Some experts felt that it may not be feasible to take account fully of the level of complexity in the 'real-world', or reflect this in interventions. The SRG felt, however, that there should be more research to gain a better understanding of complexity in public health prevention research, and of the value of 'realist' approaches to intervention development.

8.3. Assessing whether social and sector-based 'systems' can improve public health and reduce health inequalities

While not within the scope of previous NPRI funding rounds, exploration of how to better integrate and align policies, organisations and systems to achieve health improvement is an important issue that should be supported in future research. Research is needed into the development, testing and sustainable implementation (if found to be effective) of 'prevention systems' in which organisations and sectors (e.g. NHS, social care, third sector, independent sector, education) work together to create novel ways of preventing or reducing the impact of public health problems.

8.4. The important role of knowledge exchange

Throughout the workshop, consultation and review, consensus developed about the important role of both funders and researchers in facilitating the translation of research findings into policy or practice. The SRG noted how the NPRI grant holders had often engaged professional and public stakeholders late in the project, if at all. In their interviews, the NPRI-funded researchers asked for support from funders to bring researchers and policy-makers/practitioners together to enable the level of collaboration required for maximum impact. From the interviews with the NPRI funders, eight were already, or had recently become, active in this area. The range of activities instigated by funders included sharing of research findings with policy colleagues, and making funding available specifically to support translation.

The SRG took the view that while greater efforts at co-production and dissemination of findings must be a prominent feature of future prevention research programmes, more sophisticated methods of research synthesis and communication of current knowledge could provide now important insights and potential solutions for decision makers. The SRG agreed that there needs to be consideration of new ways of engaging users and decision-makers at all stages of the research process.

9. Conclusions

9.1. The NPRI met its objectives

The NPRI supported a portfolio of research that overall has been of good quality with some notable highlights. A high percentage of completed projects had met their objectives. The researchers had employed a range of approaches, including some innovative work, to answer their research questions. The SRG agreed that the initiative had addressed all of the core behaviours that the NPRI was established to address.

The outputs of NPRI projects included some high impact outcomes along with numerous important, but more incremental, additions to knowledge addressing important public health issues. The initiative had not proactively supported knowledge exchange activities but a number of NPRI investigators had made significant contributions towards dissemination activities, including highlighting the need for change and providing evidence for policy change. For example, national policy changes and public debate related to smoking cessation and reduced alcohol consumption, had been informed by NPRI-funded work. The SRG concluded that the impact of NPRI funded work on policy and practice had been good.

The NPRI funding had facilitated the learning of new skills (often among the PIs themselves); the leverage of further funding, particularly for studentships; and the building of new scientific and policy/practice collaborations. The NPRI had made a valuable contribution to building capacity in public health prevention research.

9.2. The NPRI legacy

Two major legacies of the NPRI have been expanded capacity in public health prevention research (from a very small base) and the demonstration that a large group of funders can work together to support research into important public health issues. The NPRI was set up to redress a recognised weakness in public health prevention research, and through the collective efforts of providers and recipients of funding, it has raised the profile of public health prevention research. The 'badge' of a multi-funder supported initiative was particularly helpful for building capacity and profile for the area and the NPRI funders. The initiative enabled several funders to support work that was outwith their normal funding remit and has created a desire for continued cross-disciplinary working.

The SRG concluded that the NPRI has been a pioneering and impactful funding initiative, which has unquestionably helped to strengthen UK public health prevention research.

9.3. Scope for improvement and future opportunity

Through the review of the NPRI outputs, the SRG workshop and ensuing consultation, and interviews with grant holders, several areas were identified where the impact of the NPRI research might have been even higher, or where new research endeavours might be developed.

Research challenges and opportunity

Achieving substantial, sustainable improvements in chronic disease prevention through research into behaviour and behaviour change has been, and remains, challenging. This review noted the paucity of theory-based interventions which produced large and sustained change. Findings from a small number of NPRI funded intervention studies, and research elsewhere, suggest modest improvements in public health from interventions applied to individuals when targeted at change in single health-related behaviours such as poor diet, physical inactivity, smoking or alcohol misuse. Larger effect sizes may be achieved by the use of theory-based interventions. Greater reductions in population illness or health risk might result from applying these interventions at multiple levels (individual, group, community and/or population-level). Work is needed to understand how individual components of complex interventions fit together, and how the effectiveness of different elements can be boosted. Better use of trial methodology and iterative cycles of intervention development and process evaluation that take account of what works, for whom and in what circumstances and aspects, should be encouraged.

There also needs to be better understanding of the complex interaction between individual behaviour and risk factors, and social, cultural, health-care and other determinants of health; factors which often interact in a non-linear fashion and which sometimes operate in opposite directions. Such understanding will assist with the identification of novel interventions and points at which maximum benefit may be derived. This complexity was rarely addressed in the NPRI portfolio and should be an important focus of future work.

A third stream of work should involve exploration of how to better integrate and align policies, organisations and systems to achieve health improvement. Work is needed into the development, testing and sustainable implementation (if found to be effective) of 'prevention systems' in which organisations and sectors (e.g. NHS, social care, third sector, independent sector, education) work together to create novel ways of preventing or reducing the impact of public health problems.

Key areas to be addressed in any future prevention initiative include work to narrow health inequalities and promote research into mental health and wellbeing.

How to effect better translation and knowledge exchange

While the impact of the NPRI on policy and practice has been good, there was consensus that more could be done to enhance the translation of findings into policy and/or practice, and other knowledge exchange activities. There also needs to be greater and broader synthesis and communication of research evidence for decision makers.

The NPRI researchers who had been most effective in this area were well embedded in policy and practice networks and familiar with the co-production of knowledge. Outside such networks, the potential for impact was very dependent on the skills and motivation of individual researchers. The SRG concluded that capacity and skills in knowledge exchange needs to be built among public health researchers. Best practice should be disseminated to researchers, emphasizing the advantages to both research and policy/practice from early academic and stakeholder collaboration and co-production of knowledge. As well as encouragement, practical help is needed to support PIs to build appropriate networks at the design as well as other stages of a project. Collaboration at the project level needs to be complemented by dialogue between funders, policy-makers and researchers about policy context, priorities, and research focus.

9.4. Prevention research in the new UK landscape and the increasing importance of further targeted investment

During the period of the NPRI funding, spend on public health prevention research doubled, with the expectation of a further increase in the next Health Research Analysis[29]. This is from a small base. The increase in investment has been the result of joint initiatives including the NPRI. Other innovations have included the establishment of the UKCRC[30] Public Health Research Centres of Excellence, the NIHR Public Health Research Programme, the NIHR School for Public Health Research, the Department of Health Policy Research Units and the MRC PHIND[31] schemes.

The increased availability of relevant research funding and dedicated capacity building schemes has placed the public health research community in a stronger position to deliver novel and multi-disciplinary prevention research. However, even with these welcome changes, the field remains small and there is both scientific opportunity and continued unquestionable public health need, requiring sustained increases in investment. This review has identified key areas where public health prevention research can be strengthened to develop important innovations to tackle some of the major public health challenges of today and the future.

9.5. Recommendations

A successful programme of public health prevention research involving concerted, multi partner, collaboration is needed as much today as in 2005 when the NPRI started. Scale and stability of funding, multidisciplinarity, and researcher-user cooperation remain essential. Future programmes of work should build upon the solid foundations laid down by the NPRI as follows:

- The funded work should involve a balance between observational, developmental, and intervention studies, with increased emphasis on solving problems rather than simply describing them. Future programmes should have greater focus on developing interventions that may act at a level other than at the individual (for example, group, community or population-level) or at more than one level.

- There also needs to be more work on the cost-effectiveness of public health prevention strategies, as well as the modelling of likely long term impact on disease outcome. A key priority is research into the development and testing of interventions in groups with particular needs, such as those with poor mental health, lower socioeconomic and minority ethnic groups.

- Support should be given to researcher/practitioner teams to engage in cycles of development and testing, and the use of knowledge based on implementation science and process evaluation, as well as economic analyses; to effect sustainable change. There should also be strengthened engagement and collaboration between research funders and researchers to build capacity and expertise in knowledge exchange. In parallel, funders should set clear expectations of publication and dissemination of findings arising from the work (including of negative results), and participation in knowledge exchange activities.

Suggested research themes for future work were:

IMPROVING INTERVENTIONS TO CHANGE HEALTH-RELATED BEHAVIOURS

- Increase research into the mechanism(s) of action, context, and delivery of interventions. Capturing data from aligned behavioral studies and greater exploration of external context or timing of the intervention would help inform the development of stronger intervention plans. The use of more imaginative trial designs could make individual and group level interventions more effective and/or support better targeting or adaption to sub-groups.

- Support for researcher/practitioner teams to engage in cycles of development and testing and use knowledge based on implementation science and evaluation of process, as well as economic analyses.

UNDERSTANDING COMPLEXITY IN PUBLIC HEALTH INTERVENTIONS AND EVALUATIONS

- Increase research into whole system influences on behavior and public health, to achieve deeper understanding of the complex influences and interactions that will support the development of more powerful individual and population-level interventions.

ASSESSING WHETHER SOCIAL AND SECTOR-BASED 'SYSTEMS' CAN IMPROVE PUBLIC HEALTH AND REDUCE HEALTH INEQUALITIES

- Explore how to better integrate and align policies, organisations and systems to produce 'prevention systems' in which organisations and sectors (e.g. NHS, social care, third sector, independent sector, education) work together to create novel ways of preventing or reducing the impact of public health problems.

Endnotes

1. PI stands for Principal Investigator
2. The wording of the NPRI's aims changed slightly as the initiative developed. This is the wording for the fourth call. In call 1 the strategic aims referred to objectives in terms of specific disease end points, such as cancer, coronary heart disease and diabetes, reflecting the remits of the (smaller number) of partners supporting the early call.
3. Twelve of the award holders were interviewed regarding two projects so the interviews cover 69 of the 74 funded projects
4. Here this is defined as any design that was not a definitive trial. It should be noted that a judgement had to be made on some studies that were on the cusp of a definitive effectiveness trial and further intervention development.
5. Unfinished trials tended to be the larger definitive trials.
6. Research on sedentary behaviour is included in this discussion and in Figure 5 as the category of research into 'physical inactivity'
7. This did not include meeting abstracts - see Annex 1 for details on what was counted.
8. Three of the PIs in this group of eight studies had been authors of systematic reviews, general science reviews and/or protocols acknowledging NPRI support but the reports were not deemed to be outputs from the projects. In two cases the investigators had not updated their *Researchfish* entries so there may have been some dissemination of NPRI outputs that the SRG was unaware of.
9. The Journal Normalized Citation Impact (NCI) measures the quotient of an observed citation rate and an expected citation rate for the journal in which the cited article was published. Therefore it compares the average performance, where performance is measured by the number of times the paper is cited, compared to the average performance of all papers appearing in that journal.
10. The NPRI lead investigator referred to 'teachable moments' in the cancer screening setting for changing 'lifestyles'.
11. Both Ashley Adamson and Ashley Cooper have since been promoted to Professor
12. The NHS Choices web site no longer refers to the app directly
13. For example: J Hotchkiss, C Davies, R. Dundas, N Hawkins, P Jhund, S Scholes, M. Bajekal, M. O'Flaherty, J Critchley, A Leyland, S Capewell. Explaining Trends in Scottish Coronary Heart Disease Mortality between 2000 and 2010: Socioeconomic Analysis using the *IMPACTsec* Model. A Retrospective Analysis using Routine Data. *BMJ* 2014; 348: g1088 **DOI**: 10.1136/bmj.g1088
14. http://www.hscic.gov.uk/pubs/hse08physicalactivity
15. http://www.noo.org.uk/uploads/doc510_2_NOO_Physical_activity_surveillance.pdf
16. http://ageactionalliance.org/wordpress/wp-content/uploads/2014/03/AVONet-report-2014-March.pdf
17. Start active, stay active: a report on physical activity from the four home countries' Chief Medical Officers. July 2011. https://www.gov.uk/government/publications/start-active-stay-active-a-report-on-physical-activity-from-the-four-home-countries-chief-medical-officers
18. Moore GF et al. Impacts of the Primary School Free Breakfast Initiative on socio-economic inequalities in breakfast consumption among 9-11-year-old schoolchildren in Wales. *Public Health Nutr.* 2014 Jun;17(6):1280-9. doi: 10.1017/S1368980013003133. Epub 2013 Dec 3.
19. https://www.nice.org.uk/guidance/ph45/chapter/Introduction-scope-and-purpose-of-this-guidance
20. http://www.parliament.uk/business/committees/committees-a-z/commons-select/health-committee/inquiries/parliament-2010/governments-alcohol-strategy/
21. http://www.stir.ac.uk/media/schools/management/documents/Alcoholstrategy-updated.pdf
22. There are currently 16 funders, but one funder was unable to participate in the interviews
23. The NPRI awards were made by a Scientific Committee but the NPRI was governed by a NPRI Prevention Research Advisory Board (PRAB) which shaped the calls.
24. The sum of the values reported by the NPRI grant holders in *Researchfish* as starting after October 2006 was checked and some reports of further funding, and some duplicates, were discounted. Therefore the value reported here is not fully dependent on self-report and has been verified.
25. In the interviews 34 interactions with policy-makers were reported, which was higher than the Figure reported in *Researchfish*.
26. The SRG consulted the leaders of major MRC, CSO and NIHR investments in public health, the chairs of the NIHR PHRP Boards, the past and present chair of the NPRI Scientific Committee and the directors of the UKCRC Public Health Research Centres of Excellence. The themes were also discussed at an NPRI grant holder meeting that was a satellite of the UKSBM Annual Scientific meeting held in Nottingham in December 2014.
27. 'Realist evaluation designs' refers to a theory–driven approach to intervention evaluation that at its simplest asks not 'what works?' or 'does this programme work?' but asks instead 'what works, for whom, in what circumstances and in what respects, and how?' see Pawson, R. and Tilley, N., http://www.communitymatters.com.au/RE_chapter.pdf (accessed July 2015).
28. Asset mapping, involves drawing a map of what is valuable in communities, and is an exercise in community development. In this context it can be a process of making an inventory of the resources, skills and talents of individuals, associations and organisations that can contribute to the better health of the public. These assets are not necessarily primarily responsible for health but may be part of the wider determinants of health.

29. The Health Research Analysis Forum (HRAF) consists of the 12 largest public and charitable funders of health research in the UK who have participated in both previous HRCS analyses in 2004/05 and 2009/10. The Association of Medical Research Charities (AMRC) is also a member of the HRAF and has facilitated the collection of data from 48 additional member charities for the 2014 analysis which was expected to report in 2015 before this review was published but after the last meeting of the SRG.
30. UK Clinical Research Collaboration
31. Public Health Intervention Development Scheme

A report of an independent review group prepared by the NPRI secretariat
on the NPRI outcomes and future approaches

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