Independence and mental wellbeing (including social and emotional wellbeing) for older people

Economic analysis

Optimity Advisors, commissioned by the National Institute for Health and Care Excellence

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List of abbreviations & Glossary

CCA	Cost-consequence analysis
CHD	Coronary heart disease
CUA	Cost-utility analysis
HR	Hazard ratio
IHD	Ischaemic heart disease
IMWOP	Independence and mental wellbeing in older people
LSE	London School of Economics & Political Science
NICE	National Institute for Health and Care Excellence
PHAC	Public Health Advisory Committee
RCT	Randomised controlled trial
QALY	Quality-adjusted life year

Life satisfaction scale	Measuring level of satisfaction
Lubben Social Network Scale	Measures involvement in social relationships
Perceived control scale (PCS)	Measuring perceptions of independence/being 'in control'
UCLA Loneliness Scale	Multiple versions, measuring subjective feelings of loneliness or isolation

1.0 Executive summary

Optimity Advisors has been commissioned by NICE to conduct a cost-effectiveness analysis of measures to improve and protect older people's independence and mental wellbeing. This work is to provide additional evidence to NICE and to the Public Health Advisory Committee (PHAC) tasked with producing guidance in this area, alongside the other sources of evidence that have been made available (reviews of effectiveness evidence, barriers and facilitators, current UK practice, cost-effectiveness evidence; and expert testimony).

Specifically, our aim was to conduct an economic analysis to answer four research questions:

1. What are the most effective and cost-effective ways that local authorities, other services and communities can raise awareness of the importance of older people's mental wellbeing and independence?
2. What are the most effective and cost-effective ways that local government, other services and communities can identify older people who are at high risk of a decline in their mental wellbeing or independence?
3. What are the most effective and cost-effective ways to improve or protect the mental wellbeing and/or independence of older people?
4. What links are there between the mental wellbeing and independence of older people and their: mental and physical health, capability, quality of life, isolation and participation in community, civil and family activities ("mental capital")?

To answer these questions, we first undertook a systematic literature review targeted at question 4, i.e. identifying the impact of a change in mental wellbeing and/or independence on a variety of health, isolation and participation measures.

We then selected four representative interventions from the review of effectiveness evidence provided to the PHAC by a team at LSE. For each of these, we undertook economic analysis assessing the cost of each intervention, its effects in terms of raising awareness, identifying people at risk and/or improving mental wellbeing and/or independence, and linked this to the evidence on impact assessed through our own review.

For all interventions, we presented a cost-consequence analysis, which was agreed to be the most suitable structure of analysis given the data available. For those interventions where a significant effect on loneliness was reported, we also conducted a complementary 'sub-analysis' showing cost-utility results specifically for the impact of a change in loneliness. Studies answering questions 1 and 2 were not readily available within the scope of this study, so results focus on questions 3 and 4.

1.1 Literature review

1.1.1 Methods

A systematic search strategy was developed to undertake the literature review, in collaboration with NICE and information specialist John Eyers. The search strategy was built around the basic concept of "Older People AND Independence/wellbeing AND Health-related outcomes", and the following databases were searched:

- Age Info;
- Ageline;
- ASSIA;
- Cochrane Library Databases (CDSR, DARE, Central, HTA, NHS EED);
- HMIC;

- MEDLINE & PreMEDLINE;
- Social Policy & Practice.

The resulting abstracts were screened for relevance using a comprehensive set of inclusion and exclusion criteria, encompassing date of publication, language, country (OECD only), population (i.e. healthy older people), topic and impact (i.e. providing impact data).
Grey literature from a number of websites for organisations involved in this area was also reviewed, a Google Scholar search was undertaken and citation chasing was conducted to complement the literature review.

1.1.2 Results

The literature search identified over 15,000 unique abstracts, and in combination with grey literature and additional searches 155 full texts were selected for full text screening. Relevant data was extracted from 17 studies.

Loneliness, life satisfaction, isolation, morale and social support and social networks were all identified as part of mental wellbeing and independence measures. A variety of measurement scales are used to capture this information. The most common of these are:

- Lubben Social Network Scale measuring Involvement in social relationship[12];
- UCLA loneliness scales (multiple versions) measuring subjective feelings of loneliness or isolation[3];
- Perceived control scale measuring perceptions of independence/being 'in control'[4];
- Life Satisfaction Scale measuring level of satisfaction[5].

The evidence uncovered from this review was relatively fragmented, in part because of the large number of measurement scales used and in part because many of the components of mental wellbeing and independence are measured as outcomes in their own right.

Additionally, there seems to be a great deal of interrelation between measures and outcomes (e.g. life satisfaction can both improve survival outcomes, but can also be influenced by health), which means cause and effect is difficult to establish (and there may be multiplier effects, e.g. vicious or virtuous cycles). However, the following evidence was found:

Loneliness is associated with depression[6], the likelihood of developing Alzheimer's disease[7], dissatisfaction with life, increased personal care needs and lower self-reported health, quality of life and physical activity levels[8]. For example, one study found that 15% of those who are the least lonely were depressed versus 45% of those who are the most lonely[9], and Age UK report that those who are lonely are twice as likely to develop Alzheimer's disease. [10]

Social relationships are also associated with mortality: "individuals with adequate social relationships have a 50% greater likelihood of survival compared to those with poor or insufficient social relationships. The magnitude of this effect is comparable with quitting smoking and it exceeds many well-known risk factors for mortality (e.g., obesity, physical inactivity)."[11]

Life satisfaction[1213] **& psychological wellbeing**[14] are associated with mortality and number of doctor visits; **social networks, social support** and **frequency of contact with others** can also influence mortality. For example, one study [15] found that the risk of death was 2.5 times higher in women with very little support compared with women who have higher support rates. **Optimism**[16] and **control** (or perceived control)[17] also affect older people's health outcomes. However, one study which examined control and life satisfaction found the lowest mortality risk in those with lower life satisfaction but higher feelings of control[17].

Social isolation is associated with self-reported poor health[18], and reduced quality of life[19].

Low psychological wellbeing has been linked to lower survival in men (not in women)[14].

Self-perceptions on aging, as measured by the Philadelphia Geriatric Centre Morale Scale, can be related to a decline in physical health in the later life[20].

1.2 Cost-consequence analysis

Based on the interventions identified by the LSE review team, the PHAC and NICE project team identified four intervention clusters for inclusion in the cost-consequence analysis, on the grounds that these clusters were relatively representative of different types of intervention and the LSE review identified them as promising:

1. Arts based interventions: singing;
2. Internet and computer training (ICT);
3. School based intergenerational activities/volunteering;
4. Friendship programmes.

An intervention was selected for each cluster on the basis that it showed moderate or strong evidence of a positive effect and that the quality of the study (assessed by the LSE review team) was moderate or high. Where multiple studies met these criteria, the one presenting the widest range of outcomes was selected.

1.2.1 Methods

Cost-consequence analysis was deemed the most suitable type of economic analysis for this topic, given both the lack of strong statistical impact data, the interrelated nature of mental wellbeing, independence and the impacts thereof, and the multiple ways in which the effects of the interventions are reported.

Cost-consequence analysis "does not attempt to summarise outcomes in a single measure," [21] unlike other types of economic analysis, instead providing the intervention cost and a 'balance sheet' of possible consequences where they are available, including narrative.

Costs of each intervention (versus its comparator) were assessed through our own research (where not reported by the intervention paper), drawing on published unit costs from standard national sources such as the Personal Social Services Research Unit[22] (PSSRU) and studies of similar interventions. Costs were calculated using a bottom-up approach, i.e. building up the total intervention cost from the components described in the intervention paper.

Effects were included as reported by the intervention papers.

Consequences (impact) were reported in two ways: financial consequences describe the potential savings to the health service and wider society from improved health and wellbeing; and descriptive consequences outline the likely impact to the individual in health and wellbeing terms. Consequences are reported in as much detail as the data allow, and are quantified when possible.

1.2.2 Results

Arts-based interventions: Singing

The singing intervention[23] consisted of a 30 week, weekly chorale singing programme conducted in the USA. The comparator was 'usual activity', i.e. no singing programme. The cost was estimated at £7,740, or £86 per person. Positive outcomes were found for self-rated overall health, number of doctor visits in the past 12 months, number of over the counter medications, number of falls, morale, and weekly level of physical activity.

Financial consequences were estimated where possible: participants were estimated to save £2.40 on average as a result of one fewer over the counter medication per year, while the health system saves on average £92.13 per person as a result of two fewer GP visits per year. These savings to society slightly outweigh the intervention cost.

The intervention reduced falls by 0.17 per year compared to a 0.19 increase in the control arm. Falls can often be fatal: around 28% of older people died within 12 months of a fall according to the King's Fund[24], and for those who suffer a hip fracture, half "never return to their previous level of independence, and approximately 20% enter a care home"[25]. Although these very serious outcomes are more likely to occur in older people with existing substantial health problems, significant benefits are still to be expected. Additionally, hospital admissions that result from hip fractures cost on average £5,744[25]. It is difficult to interpret the extent to which many of the physical gains reported occur due to the social, or the physical aspects of a singing programme (and thus to what extent they are generalizable to other arts-based interventions). Another study in this area has not found significant gains in the area of physical quality of life[26].

For a relatively small cost (£86 per person), this intervention would be expected to deliver both cost savings and improved health outcomes versus the comparator. Finally, a UK-based economic study on a similar singing programme has recently been published[27].

Internet and computer training intervention

The internet and computer training intervention[28] consisted of a course in basic computer operation, use of email and an introduction to the web, conducted in the US. The comparator was 'no training', i.e. individuals who were on a waiting list for training. Follow up was carried out after 5 months. The cost was estimated at £27,060, or £564 per person. The intervention found no statistically significant direct impact on participants' loneliness/life satisfaction and depression, it did boost weekly computer use.

However, frequency of computer use has been linked to improvements in various wellbeing measures, as measured by Cotten and colleagues (2013), that may well result for the intervention group over a longer time period: [29] computer use decrease loneliness, made it easier to reach people, contributed to staying in touch, made it easier to meet new people, increased the quantity of communication with others, made the respondent feel less isolated, helped them feel more connected to friends and family and increased the quality of communication. This in turn may have positive outcomes for depression, health, dementia (including Alzheimer's disease, although this has not been modelled in this analysis) and mortality. (Other studies identified in the LSE Evidence Review also supported a link between internet training and decreased loneliness.)

We draw attention to the fact, however, that this study was completed in 2002, so more up to date research may see different results (although it is difficult to say to what extent and in which direction).

School-based intergeneration and volunteering intervention

The school-based intergenerational activities and volunteering intervention[30] consisted of senior volunteers engaged in reading picture books to children (following an education and engagement programme) and was conducted in Japan (versus no programme). The cost of the intervention was estimated at £691, or £10 per participant.

On nine effect measures the intervention delivered an improvement in areas such as connecting with distant (i.e. non-family) children, self-rated health and providing social support, which are likely to improve mortality outcomes.

We calculated the value of volunteering as an outcome measure, based on a valuation of participant's time as if it were a paid job. This equated to a total of £269,973 at 21 month follow up, or £81 per session. However, on one effect measure – received support from friends – there was significant decline, which could have an adverse effect on mortality. The authors "pride may have been a factor that prevented [participants] from accepting social support."

Finally, the issue of transferability of results from Japan to the UK was noted.

Friendship programmes

This intervention[3132] was a friendship enrichment programme targeting older women (versus no programme), including lessons focused on topics related to friendship. The total cost was estimated at £4,626, or £77 per participant, or £7,190/£120 when including follow-up interviews and tokens given out for participating in follow-up interviews.

Positive results were found for increased friendships, contract with friends, increased number of friends, lower negative affect, self-esteem, life satisfaction, loneliness and self-efficacy. This is likely to improve health and reduce mortality and improve quality of life.

1.3 Cost-utility analysis

1.3.1 Method

For loneliness, a cost-utility analysis was conducted. This was intended to complement the CCA for those interventions where a loneliness outcome was reported, on the basis that compared to independence and mental wellbeing in general, the impact of a change in loneliness on health outcomes such as depression and dementia has been more rigorously established; and producing a sub-analysis of cost-utility allows the establishment of QALY gains (QALYs are a measure of quality of life over time, described below) and a cost per QALY metric, in line with other NICE guidance. However, it must be noted that this only provides a partial view of the benefits of an intervention that impacts on more than loneliness, (and that loneliness impacts on more than health outcomes).

A model was developed from which the impact of an intervention on loneliness can be entered, in the form of a threshold, i.e. number of people moving from 'lonely' to 'not lonely'. This method was chosen due to a lack of data enabling a more detailed assessment.

The relative impact of being 'not lonely' versus being 'lonely' on the following health outcomes were included: depression, dementia (delaying onset) and physical activity. Physical activity (itself calculated as two stages – active or not) was used to assess the impact on diabetes, stroke and coronary heart disease. It is not claimed these are the only benefits of reduced loneliness, rather that good statistical data was available to calculate these benefits.

The model calculated the costs of the intervention (input from the CCA), and the resulting improvement in health outcomes. Improving health outcomes carries a financial benefit to the health service (the cost of treatment) and a QALY benefit to individuals. Mortality outcomes were not included.

1.3.2 Results

Two interventions saw a statistically significant impact in loneliness, the internet and computer training intervention (greater computer use was measured in the intervention paper and this was linked to a study showing greater computer use led to reduced loneliness); and the friendship programme for women.

Internet and computer training intervention

A 2% reduction in loneliness was calculated based on figures reported in both the White[33] and Cotten[29] papers, and our own assumptions about the distribution of loneliness values, detailed in the main report. The cost of the intervention per person was £564. Putting these values into the model gave the following impact on health outcomes:

Table 1: Internet and computer training impact on health outcomes

Health Outcome	% reduction	Cost saving per person*	QALY gain per person
Depression	0.67%	£48	0.0138
Dementia	0.14%	£44	0.0005
Physical activity	1.24% increase	*Only impact on subsequent diseases measured*	
Diabetes	0.09%	£9	0.0016
Stroke	0.1%	£62	0.0005
CHD	0.17%	£61	0.0050

Table 1 shows that all health outcomes improved slightly, generating some cost savings to the health service and QALY gains. In total, cost savings per person equated to £224, reducing the cost of the intervention to a net cost of £340. Total QALY gains per person were 0.021, resulting in an ICER (Incremental Cost-Effectiveness Ratio, or cost per QALY) of £15,962. This falls under NICE's implied cost-effectiveness threshold of £20,000, so looking only at the impact of the intervention on loneliness and the health outcomes above resulting from loneliness (i.e. leaving out all the other benefits discussed in the cost-consequence and potentially others not captured in the study) the intervention can be deemed cost-effective.

Friendship programmes

A 3% reduction in loneliness was calculated based on figures from the study paper, and assuming a normal distribution of loneliness scores. The cost of the intervention per person was £77. The resulting impact of the intervention on health outcomes was as follows:

Table 2: Friendship programme impact on health outcomes

Health Outcome	% reduction	Cost saving per person*	QALY gain per person
Depression	1.04%	£74	0.021
Dementia	0.21%	£68	0.001
Physical activity	1.93% increase	*Only impact on subsequent diseases measured*	
Diabetes	0.13%	£24	0.004
Stroke	0.15%	£129	0.001
CHD	0.27%	£96	0.008

Again, a slight improvement in all health outcomes was observed. Total cost savings to the health service equated to £391, outweighing the intervention cost by £314 and thus producing a net saving to society. 0.035 QALYs per person were gained, meaning that as a cost-saving and health improving intervention, the programme was considered dominant over its comparator (no programme). Thus even just looking at the impact of the intervention on loneliness and its effects on the health outcomes above, excluding all other potential benefits, the intervention is unambiguously cost-effective.

1.4 Conclusions

The literature review indicated that the evidence on the impact of independence and mental wellbeing on health and other outcomes was fragmented. Partly this is due to many studies measuring independence and mental wellbeing as outcomes in their own right. It is also due to the many measurement scales used, and the complex and interrelated relationships between these outcomes, making cause and effect difficult to establish

(and most likely not linear). However, the results did suggest that an improvement in independence and mental wellbeing is associated with many other benefits, in terms of physical health, social relationships, mental health and mortality.

In the cost-consequence analyses, all four interventions delivered positive benefits versus a 'do nothing' comparator. Although the evidence presented in these economic analyses does require some subjective judgement, the cost-consequences presented above suggest that many interventions such as these can be helpful in improving physical and mental outcomes for healthy older people, and may well be cost-effective (if some of the unquantified benefits deliver similar gains to reducing loneliness). The cost-utility analysis conducted on two interventions showed that in terms of health outcomes from reduced loneliness alone, the internet and computer training intervention was cost-effective and the friendship programme was both cost-saving and effective.

The limitations of this analysis include the small number of interventions (however, the methodological approach could be rolled out to include more programmes) and relatively short follow-up in some studies. It was also not possible to report the effectiveness of programmes to raise awareness and identify people in need from these studies, given that this was not their focus (and future research is required in this area). Finally, while some programmes were ongoing, i.e. individuals could participate in them indefinitely, others (internet training and friendship programmes) were one-off, and it is difficult to know how this difference may affect longer-term outcomes.

Additionally, each intervention was compared only to 'no programme' – in reality, a Local Authority will have to consider what else is available in the area (older people may join more than one programme, and those involved in programmes already); and the issue of achieving and sustaining uptake of programmes in the 'real world' was also not considered. This analysis has shown that several types of programmes can have positive effects – perhaps an immediate question for Local Authorities to consider is how to get older people to participate in one or more programmes, regardless of the specific nature of each programme.

As well as the above, areas where future research would be useful are: linking together the myriad effects of improving independence and wellbeing, as well as what factors cause such an improvement (there may well be a 'virtuous cycle' of improvement) and understanding to what extent interventions can be tailored towards individuals in a given area, to ensure that all older people are included, rather than a potential bias where only those interested in a particular activity take part.

2.0 Introduction

2.1 Background

NICE has been tasked with developing guidance on "Interventions to improve or protect independence and mental wellbeing for older people". For this purpose, older people are defined as:

a) People aged 65 or over; and

b) People aged 55 or older who are aging prematurely or at risk of developing age-related physical and mental conditions.

A detailed specification of the guidance is provided in the scope[34].

Mental wellbeing and independence of older people are two key related but distinct aspects of the health and wellbeing of older people. The terms are defined as follows by The National Institute for Health and Care Excellence. *Mental wellbeing*: "…refers to 'feelings' (emotional and psychological wellbeing, including self esteem) and the ability to 'function' socially (social wellbeing, including the ability to cope [be resilient] in the face of adversity). It also includes being able to develop potential, work productively and creatively, build strong and positive relationships with others and contribute to the community (Foresight 2008[35])"[34]. *Independence* is "…defined as an older person having the capacity to make choices and to exercise control over their lives. It also includes the ability to live independently, with or without support"[34].

Preserving both mental wellbeing and independence is important for older people to remain functional members of society. Loss of mental wellbeing or independence has impacts on older people's level of social isolation, levels of loneliness, quality of interpersonal relationships, ability to care for dependent individuals, engagement in the community or social events, ability to undertake formal or informal employment and ultimately can lead to the development of both mental and physical illness, and eventually requiring admission to a care home. Ultimately these outcomes are also associated with substantial economic costs and benefits[35].

To develop this guidance with NICE, a Public Health Advisory Committee (PHAC) has been established. PHACs consist of "a Chair, core and topic expert members … drawn from the NHS, local government, healthcare professions, academia and the wider public health community."[36] To assist in the PHAC's deliberations on the effectiveness and cost-effectiveness of measures which aim to raise awareness of older people's independence and mental wellbeing, identify older people at high risk of a decline in their independence and mental wellbeing and improve or protect older people's independence and mental wellbeing, they have had access to the following sources of evidence:

- A review of effectiveness evidence
- A review of barriers and facilitators
- A review of current UK practice
- A review of cost-effectiveness evidence
- Expert testimony

The first three of these have been commissioned from a team led by researchers at the LSE (referred to in this report as the LSE review team). NICE undertook the review of cost-effectiveness evidence, while expert testimony has been presented to the PHAC from NICE as well as a number of independent experts including representatives of voluntary and statutory services intended to address issues of independence and mental wellbeing (such as loneliness) among older people. The findings from each strand of evidence have been presented to the PHAC as they have emerged over a period of around six months, encompassing five PHAC meetings. The role of the PHAC is to consider this body of evidence (and the evidence presented in this

report) when making judgements about which approaches to tackling mental wellbeing and independence in older people are effective and cost-effective.

Optimity has been commissioned by NICE to conduct cost-effectiveness analysis of interventions in this area. This work builds on the review of existing cost-effectiveness evidence, which noted that "the evidence base with respect to cost-effectiveness of interventions to improve and promote mental wellbeing of older people is very limited."

2.2 Aims

Our aim was to conduct an economic analysis to answer four research questions in the area of independence and mental wellbeing in older people (IMWOP):

1. What are the most effective and cost-effective ways that local authorities, other services and communities can raise awareness of the importance of older people's mental wellbeing and independence?
2. What are the most effective and cost-effective ways that local government, other services and communities can identify older people who are at high risk of a decline in their mental wellbeing or independence?
3. What are the most effective and cost-effective ways to improve or protect the mental wellbeing and/or independence of older people?
4. What links are there between the mental wellbeing and independence of older people and their: mental and physical health, capability, quality of life, isolation and participation in community, civil and family activities ("mental capital")?

To answer these questions, we selected a number of representative interventions from a review conducted by the LSE review team and based on advice from the Public Health Advisory Committee (PHAC) as to intervention types of interest. For each of these, we undertook economic analysis assessing the **cost** of each intervention, its **effects** in terms of raising awareness, identifying people at risk and/or improving mental wellbeing and/or independence, and the subsequent **impact** on a variety of health, isolation and participation measures that a potential improvement could generate (i.e. question 4).

Given the evidence available for the interventions reviewed, the focus of our analysis was on questions 3 and 4 (improving or protecting mental wellbeing and/or independence, and the subsequent impact on that), although evidence to answer questions 1 and 2 is reported where available.

In order to assess **impact** (question 4), we conducted a systematic literature review, including evidence from grey literature. Methods and results for this review are presented below.

These impact data were then combined with **effect** data from the interventions themselves (identified from the LSE review), and **cost** information from our own research in order to conduct the economic analysis. For all interventions, we presented a cost-consequence analysis, which was agreed to be the most appropriate approach to the analysis given the data available. For those interventions where a significant effect on loneliness was reported, we also conducted a sub-analysis showing cost-utility results specifically for loneliness. This is explained in more detail below in the report.

3.0 Literature review

3.1 Methods

A systematic search strategy to answer question 4 (impact of improvements in independence and mental wellbeing), proposed by NICE, was developed by John Eyers (an experienced information retrieval specialist from the London School of Hygiene & Tropical Medicine) for the following databases:

- Age Info;
- Ageline;
- ASSIA;
- Cochrane Library Databases (CDSR, DARE, Central, HTA, NHS EED);
- HMIC;
- MEDLINE & PreMEDLINE;
- Social Policy & Practice.

The search strategy was built around the basic concept of "Older People AND Independence/wellbeing AND Health-related outcomes", in order to identify studies that measured independence and wellbeing and linked this to health-related outcomes, and full details are given in the appendix. The search was undertaken by John Eyers.

A comprehensive set of inclusion and exclusion criteria consistent with the project scope was applied to the titles and abstracts of all publication citations retrieved from the searches. Screening was conducted by a team of reviewers, after which a more detailed secondary screening of included abstracts was conducted by one reviewer to further exclude irrelevant abstracts.

Inclusion/exclusion criteria are shown in the table below:

Table 3: Inclusion/exclusion criteria

Criteria	Notes
Date	Studies published before 2003 were excluded
Language	Only studies published in English were included
Country	Only studies conducted in an OECD country were included
Population	The study had to relate to people aged 65 or over, or people aged 55+ who are ageing prematurely and are particularly at risk of the same physical and mental conditions as people aged 65 or over
Population	Studies were excluded if they were about people who live in a care home or attend one on a day-only basis; or who have substantial health or social care needs, e.g. due to dementia or another pre-existing cognitive impairment
Topic	Studies had to relate to mental wellbeing and/or independence in older people
Impact	Studies had to report on the linkages between the mental wellbeing and independence of older people and their: mental and physical health, capability, quality of life, isolation and/or participation in community, civil and family activities

In addition to the database searches, Google Scholar was searched (using the string "~"Older People" ~Independence ~wellbeing ~loneliness ~outcomes ~impact"), citation chasing was undertaken, and the following websites were reviewed for grey literature:

- Age UK;
- Joseph Rowntree Foundation;
- Independent Age;

- Campaign to End Loneliness;
- Community Service Volunteers;
- Royal Voluntary Service;
- Age Concern England;
- Centre for Policy on Ageing;
- Help the Aged;
- Mental Health Foundation;
- Sainsbury Centre for Mental Health.

Full texts (and equivalent) included after this screening process were then reviewed by an economist (with assistance from two other researchers) in order to extract relevant data. Data were presented in terms of the measurement scale used to assess independence and/or mental wellbeing, and the impact associated with a change in values on that scale.

These data were then used to inform the economic analysis.

3.2 Results

The literature search identified over 15,000 abstracts. 243 selected abstracts were double screened, leaving 84 papers for full text review. We also reviewed grey literature, conducted citation chasing and a Google Scholar search. In total, 155 papers were selected for full text screening. Relevant data was extracted from 17 papers. The flow of the literature is presented below.

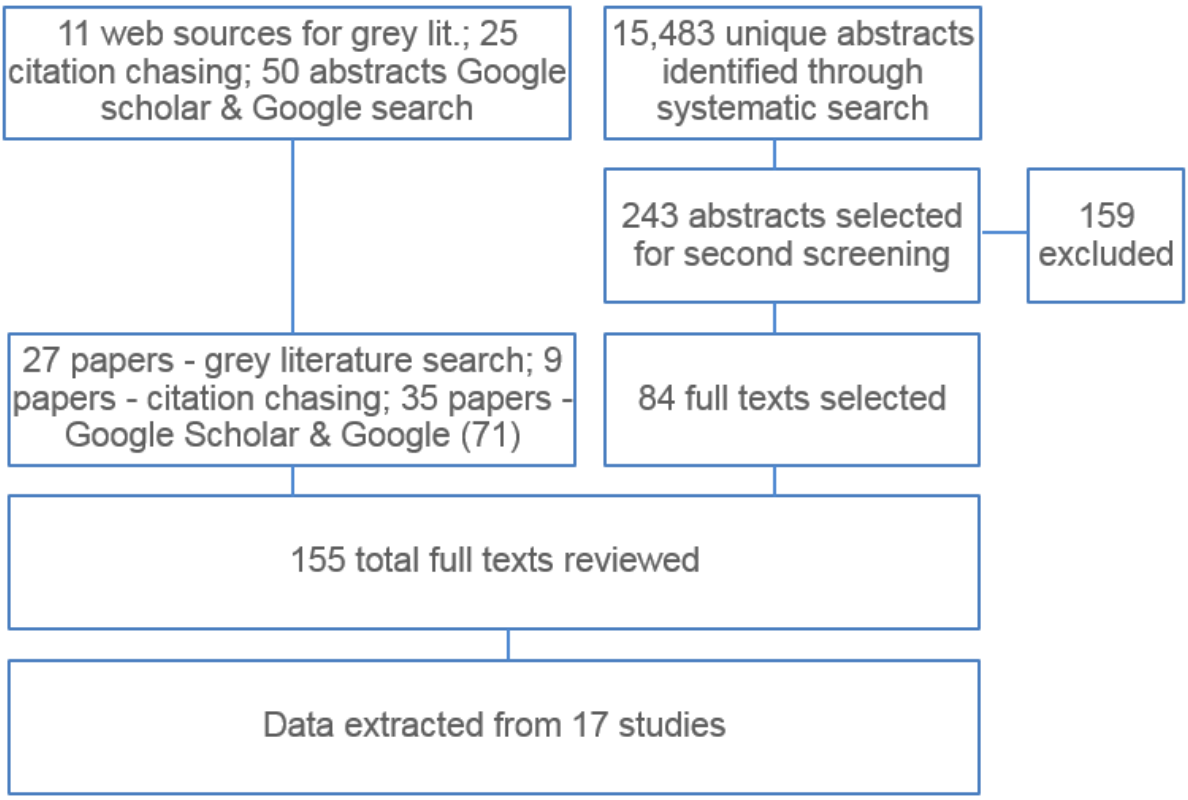


Figure 1: Flow of the literature

3.2.1 Key findings

Loneliness, life satisfaction, isolation, morale and social support and social networks were all identified as part of mental wellbeing and independence measures. The literature search revealed the number of measurement scales assessing loneliness, depression, life satisfaction etc. Here we have summarized the most commonly used scales:

- Lubben Social Network Scale measuring Involvement in social relationship[1,2];
- UCLA loneliness scales (multiple versions) measuring subjective feelings of loneliness or isolation[37];
- Perceived control scale measuring perceived control over one's life[38];
- Life Satisfaction Scale measuring level of satisfaction[39].

Loneliness is associated with depression[6]. A study found that 15.2% of those who are the least lonely score in the depressed range, vs. 45% of those who are the most lonely[9]. Loneliness is also linked to the likelihood of developing Alzheimer's disease[7]. According to Age UK, "people with a high degree of loneliness are twice as likely to develop Alzheimer's as people with a low degree of loneliness"[40]. People who are lonely report higher dissatisfaction with life compared with the not lonely group (15% vs. 3% respectively). People who are lonely also report increased needs of personal care and lower self-reported health. People considered lonely also say that poor hearing, poor sight and poor mobility affects things they would like to do compared with the not lonely group. People who are lonely think that better social life would improve their quality of life[41]. Loneliness can also influence physical activity levels[42].

Social relationships are also associated with mortality: "individuals with adequate social relationships have a 50% greater likelihood of survival compared to those with poor or insufficient social relationships. The magnitude of this effect is comparable with quitting smoking and it exceeds many well-known risk factors for mortality (e.g., obesity, physical inactivity)"[11].

Mortality levels are also higher in people with low life satisfaction levels[4313] and low psychological wellbeing[14]. Higher life satisfaction was linked to fewer doctor visits[44]. Social networks can be essential in survival and mortality[1116]. Frequency of contacts can also influence mortality[45]. Assistance received from a person's social network can influence mortality rates. Lyyra and Heikkinen (2006) [46] found that the risk of death was 2.5 times higher in women with very little support compared with women who have higher support rates. Optimism[16] and control (or perceived control)[13] also affect older people's health outcomes.

Self-reported poor health is linked to social isolation[18], and social isolation is associated with reduced quality of life[19]. Low psychological wellbeing has been linked to lower survival in men (not in women). Self-perceptions on aging that is measured by the Philadelphia Geriatric Centre Morale Scale can be related to a decline in physical health in the later life[47].

3.2.2 Findings by paper

In this section, we review each study in more depth. The study summaries are presented in alphabetical order by first author.

Adams et al. (2004)[9] examined the link between loneliness and depression among older adults aged 60-98 in the US. Most of the respondents were females (74%). The authors conducted a mail survey of elderly residents and examined data on loneliness and depressive symptoms. Depression was measured on the Geriatric Depression Scale (GDS)[48]. Loneliness was measured by the UCLA Loneliness Scale, version 3[49]. The involvement in social relationships, including networks (family, friends, confidant relationships etc.) was studied on the Lubben Social Network Scale[50]. The authors concluded that loneliness may be a direct contributor to depression; of those who were the loneliest, 45% were depressed. Of those who were depressed, 40% were

most lonely; and 15.2% of those who are less lonely score in the depressed range, vs. 45% of those who are the most lonely[9].

Barefoot and colleagues (2005)[51] assessed the relationship between social network diversity, risk of Ischemic Heart Disease (IHD) and total mortality. The paper presents findings from a longitudinal study (Copenhagen City Health Study). The mean age of the participants was 57.5. The social network questionnaire was developed to measure frequency of contacts participants had with parents, children, other family members, a spouse or partner, colleagues from work (after work), neighbours, friends from youth and other friends. Barefoot et al. found hazard ratios for mortality and IHD associated with frequency of contact with sources of social support (at least monthly compared to rarely or never). Fully adjusted hazard ratios (HRs) of mortality and IHD by contact with sources are as follows, and represent that for most sources of contact, at least monthly contact results in a lower risk of mortality and IHD (specifically, the HR relates to the rate at which individuals experience these events in the 'at least monthly' group compared to the 'rarely or never' group):

Table 4: Hazard ratio of mortality and IHD and social support

Source of contact	HR of mortality	HR of IHD
Parents	0.82	0.42
Children	0.95	0.89
Family	0.89	0.68
Colleagues	1.06	0.83
Neighbours	1.09	0.95
Friends	0.95	0.74
Spouse/partner	0.81	0.80

The *Independent Age* report[18] explored the experiences of older men who are socially isolated or lonely. The research was based on English Longitudinal Study of Ageing (ELSA) data. The Independent Age study found that 1.2 million of older men in England (2012/13) report some degree of social isolation (defined as: "…broadly refers to the absence of contact with other people") and over 700,000 older men reported a high degree of loneliness (defined as: "…a subjective perception in which a person feels lonely"). The study also found that older men are also more isolated than women.

Isolated and lonely men report poor health (28%) compared with 5% of non-lonely men. Around 26% of the most isolated men were depressed compared with 6% of least isolated.

A study[19] assessed a relationship between levels of social engagement and its links with wellbeing and community attachment – a "Call-Me" project. A questionnaire was distributed in 4 disadvantaged urban communities in Manchester, England among elderly residents (mean age ~72). Levels of social engagement and wellbeing/loneliness were measured using the Berkman-Syme index[52], the adapted Keele Assessment of Participation instrument[53], the questionnaire from "Call-Me" project[5455] and the Amsterdam Loneliness Scale[56]. Beech and Murray (2013) found that over 65% of men experienced some degree of loneliness and the mean health-related quality of life score for respondents was 0.604, lower than the UK mean (0.780) for a population of similar age.

An Age UK report summarizes evidence on loneliness in the community. Here, loneliness was described as "…an individual's personal, subjective sense of lacking desired affection, closeness, and social interaction with others. Although loneliness has a social aspect, it is also defined by an individual's subjective emotional state. Loneliness is more dependent on the quality than the number of relationships". Social isolation "…refers to a lack of contact with family or friends, community involvement, or access to services". Loneliness and isolation is found to be related to smoking and depression, as well as a doubled risk of developing Alzheimer's disease[57].

Association between loneliness and physical activity levels was examined by Hawkley and colleagues (2009) [58]. Cross sectional data was collected over 3 years among older Americans with mean age 57.4. Hawkley et al

(2009) found that loneliness was associated with a significantly reduced odds of physical activity (OR = 0.65). The study also found that loneliness predicted a diminished OR of physical activity in the next two years (OR = 0.61), and a greater likelihood of transitioning from physical activity to inactivity (OR = 1.58).

A study described changes in depressive symptomatology over 10 years among 75 year old residents in Finland[6]. Depressive symptoms were measured on the Center for Epidemiologic Studies Depression Scale (CES-D)[59]. The cohort was followed up at 5 and 10 years. Heikkinnen and Kauppinen (2004) found that loneliness predicted depressive symptomatology in the elderly.

A meta-analysis was conducted by Holt-Lunstad and colleagues (2010)[11] to establish the link between social relationships and mortality risk/survival. The data was collected from 148 studies. Holt-Lunstad et al. (2010) estimated the influence of social relationships on risk for mortality. The analysis concluded that "…the random effects weighted average effect size was OR = 1.50…, indicating a 50% increased likelihood of survival for participants with stronger social relationships". The effect was sustained across gender, health status, cause of death, age (most studies in the meta-analysis had an average age in the 60-80 range but some were under 40) and follow up.

Kim and colleagues (2014)[60] tested the relationship between life satisfaction and frequency of doctor visits. Kim et al. examined whether higher life satisfaction, measured on the Satisfaction with Life Scale (SWLS)[61] was related to a lower level of doctor visits. Participants over age 50 from the Health and Retirement Study (US) were followed up for 4 years. The study found that higher life satisfaction was associated with fewer doctor visits. The authors found that a one unit increase in life satisfaction was associated with an 11% decrease in doctor visits (RR=0.96). Compared with the least satisfied participants, the most satisfied participants made 44% fewer doctor visits (RR=0.96).

Data from the German cohort from the MONICA (Monitoring Trends and Determinants on Cardiovascular Diseases Augsburg) study was analysed by Lacruz and colleagues (2011)[62]. The data was analysed to identify the key factors that determine life satisfaction rates and to analyse the impact of life satisfaction on mortality. Life satisfaction was measured on a 6 level Likert scale. The analysis found a gender stratified association between life satisfaction and mortality. The hazard ratio for men was 0.55; however, there was no association for women.

Findings on mortality from an older Finnish cohort were summarized by Lyyra and Heikkinen (2006)[63]. The study examined the effect of perceived social support on mortality over 10 years. The Social Provision Scale was used to measure perceived control. Lyyra and Heikkinen (2006) found that the risk of death was almost 2.5 times higher in women in the lowest tertile of non-assistance-related social support. There was no association between perceived social support and mortality among men.

The impact of psychological well-being on survival was assessed by Nilsson and colleagues (2011)[14]. Psychological well-being was studied on the Psychological General Well-Being (PGWB) scale where higher scores indicate better functioning. The authors concluded that PGWB score was significantly related to 10 year survival in men (RR per 10 point change in PGWB score = 0.80), but not for women.

The relationship between changes in self-perceptions of aging (SPA) and physical functioning was studied by Sargent-Cox and colleagues (2012)[64] using data from the Australian Longitudinal Study of Aging. The authors concluded that more positive SPA can be protective of decline in physical functioning in the later life.

Participants were recruited from General Practices in the London area to study whether optimism measured on the Life Orientation Test was associated with a number of health behaviours, such as smoking, alcohol consumption and physical activity[16]. The participants were older adults aged 65 to 80 living in urban and

suburban districts of London. Steptoe and colleagues (2006) concluded that optimism was associated with healthy ageing.

The impact of life satisfaction and control beliefs on healthy ageing and mortality was studied by Wiest and colleagues (2013)[13]. The Satisfaction with Life Scale was used to measure the level of satisfaction[61] and the dispositional Hope Scale[65] was used to assess general control beliefs. The data was extracted from the German Ageing Survey (DEAS). The authors concluded that "…effects of low control beliefs can be buffered by life satisfaction, and unexpectedly, that high levels of both factors are not most protective against mortality". Somewhat surprisingly, individuals with the lowest mortality risk were those with high control beliefs but lower life satisfaction scores. The authors suggested this may fit in with self-regulation theory, that these individuals believe they have not lived up to their goals but that they can achieve them, and thus "might have a higher life expectancy because they still want to achieve targeted objectives"[13].

The impact of loneliness on Alzheimer's disease was studied by Wilson and colleagues (2007)[7] using a longitudinal cohort. They found that more frequent social activity was associated with reduced Alzheimer's disease risk (RR=0.52) but that social network size was not relate to risk of disease (RR=1.01). All in all, risk of Alzheimer's disease was more than doubled in lonely people compared with not lonely people.

Findings from Coventry, UK were summarized by Woolham and colleagues (2013)[66]. The authors investigated factors associated with loneliness among older adults (55+) using data collected through surveys. Woolham and colleagues (2013) found that people who are lonely reported higher rates of poor hearing and poor sight, higher personal care needs and mobility problems compared with less lonely participants. People who were classified as lonely also believed that a better social life would improve their quality of life.

4.0 Cost-Consequence Analysis

4.1 Selection of interventions

Based on the interventions identified by the LSE review team, the PHAC and NICE project team identified four intervention types for inclusion in the cost-consequence analysis, on the grounds that these intervention types were relatively representative of the six different clusters of intervention identified in the LSE review and were identified as promising. The intervention categories were agreed with the PHAC and the NICE project team. The following intervention types were selected for modelling:

1. Arts based interventions: singing;
2. Internet and computer training (ICT);
3. School based intergenerational activities/volunteering;
4. Friendship programmes.

N.B. A fifth intervention type, telephone befriending, was also selected for inclusion but data on the intervention that was intended to be analyses was not received in time

The process for selecting interventions within these four clusters to be modelled included two steps. First, we looked at types of intervention and excluded those for which the evidence statements proved by the effectiveness review teams were not moderate or strong – i.e. we only considered intervention types for which there was moderate or strong evidence of a positive effect.

The second step consisted of selecting the best available evidence within each type of intervention. In order to do so, we selected interventions that were part of an evidence statement that was moderate or strong for which:

- A significant positive effect was found;
- The quality of study – assessed by the effectiveness review team – was moderate [+] or high [++] quality;
- If there were multiple studies fulfilling these criteria, we have selected the one with the widest range of outcomes measured.

For these interventions, we then carried out cost-consequence analysis, and for those interventions where significant impacts on loneliness were reported, this was complemented with a loneliness-specific cost-utility analysis (due to greater availability of quantitative data on the impact of loneliness on other health outcomes). The economic analysis was conducted in line with NICE's "Methods for the development of NICE public health guidance."[67]

Finally, each intervention's benefits and wider impacts was classified according to the theoretical model of independence and mental wellbeing put forth by Mima Catten, a member of the PHAC. This is given in the appendix.

4.2 Analysis methodology

Cost-consequence analysis (CCA) was deemed to be the most suitable type of economic analysis for this topic, and this was agreed with the PHAC and the NICE project team.

CCA compares costs (i.e. the cost of implementing a programme or intervention) with its consequences, such as health outcomes, quality of life, wellbeing, or cost savings. "Unlike cost-benefit analysis or cost-effectiveness analysis, it does not attempt to summarise outcomes in a single measure (such as the quality-adjusted life year) or in financial terms. Instead, outcomes are shown in their natural units (some of which may be monetary) and it is left to decision-makers to determine whether, overall, the treatment is worth carrying out"[68]. In CCA, a 'balance sheet' of monetary, quantitative, and descriptive consequences is put together.

CCA was thus selected as:

- There is limited strong statistical evidence on the relationships between intervention effects and subsequent impacts, compounded by the variety of ways in which effects are reported
- The interrelated nature of mental wellbeing, independence and impacts such as life satisfaction and mental capacity makes it very difficult to definitively assess cause and effect and report a statistical outcome

Costs of each intervention (over and above its comparator) were assessed through our own research (where not reported by the intervention paper), drawing on published unit costs from standard national sources such as the Personal Social Services Research Unit[69] (PSSRU) and studies of similar interventions. Costs were calculated using a bottom-up approach, i.e. building up the total intervention cost from the components described in the intervention paper.

Effects were included as reported by the intervention papers.

Consequences (impact) were reported in two ways: financial consequences describe the potential cost savings to the health service from improved health, quality of life etc.; and descriptive consequences outline the likely impact to the individual in health and wellbeing terms. While intervention effects are reported only from the original study paper, consequences draw on the literature identified in our systematic review as well as any other available data found through searching specifically for each CCA.

Consequences are reported in as much detail as the data allow, and are quantified when possible.

4.3 Results

4.3.1 Arts based intervention: singing

The table below presents key findings from the cost-consequence analysis, including a short description of the intervention, study outcomes as reported directly in the text (whereby green indicates a positive outcome; amber no difference or a non-statistically significant finding; and red indicates a negative outcome), as well as a description of consequences, and any financial consequences that could be calculated.

More detail on how these results were calculated is shown below this table.

Table 5: key findings

Intervention Paper(s)	Cohen, G. D., Perlstein, S., Chapline, J., Kelly, J., Firth, K. M. & Simmens, S. 2006. The Impact of Professionally Conducted Cultural Programs on the Physical Health, Mental Health, and Social Functioning of Older Adults. Gerontologist, 46, 726-734.
Intervention	Chorale singing participation vs. usual activity
Study design	• Conducted in USA • Quality score + • Quasi-experimental study • Sample size 90 (intervention), 76 (controls)

	• 78% of participants were female • Follow up after 12 months	
Intervention description	The intervention lasted for 30 weeks with weekly singing rehearsals as well as public performances several times during the intervention period (no. of public performances not specified)	
Intervention cost	**Estimated at £7,740 or £86 per person**	
Study outcomes	**Physical health**	
	Self-rating of overall health (0-10 scale)	Improved slightly (1%) in intervention arm Decreased slightly (5%) in control arm
	Number of doctor visits in past 12 months	Increased in both, but 3x as much in control arm 0.91 more visits (16%) 3.4 more visits in control (46%)
	Number of over the counter medications	Increased in both but double as much in control arm
	Number of falls (instances of falls during the past 12 months)	Decreased in intervention arm Increased in control From 0.4 to 0.23 in intervention arm From 0.36 to 0.55 in control arm
	Other health problems (binary question where 0=no other health problems, 1=other health problem present)	Worsened in both groups but difference not statistically significantly
	Mental health	
	Morale (0-17 scale)	Mean morale decreased slightly in both groups, more so for control. From 14.15 to 14.08 in intervention arm From 13.51 to 13.06 in control arm
	Loneliness	No statistically significant difference between groups
	Depression	No statistically significant difference between groups
	Physical activity	
	Total level of activity	No statistically significant difference between groups
	Weekly level of activity	Decreased in both, but more so in control 20% decrease vs. 47%
Financial consequences	We estimated financial consequences where possible: Participants save on average £2.40 as a result of one fewer over the counter medication per year. The health system saves on average £92.13 per participant as a result of two fewer GP visits per year. These savings to society slightly outweigh the intervention cost (£94.53 vs. £86) and do not include the potentially significant additional savings from a reduction in falls.	

	The intervention reduced falls by 0.17 per year compared to a 0.19 increase in the control arm. Reducing falls prevents hospital admissions that result from hip fractures (costing on average £5,744)[25], among other savings, as well as benefits discussed below.
Descriptive consequences	While the intervention showed no statistically significant impact on participants' loneliness, depression, total level of activity and 'other health problems' versus the comparator, it appeared to boost weekly activity and overall health – all of which contribute to improving quality of life and preventing decline. Morale slightly declined in both groups, but more in the comparison group. Health service usage did not increase as much as in the comparator group, indicating better health outcomes and providing savings to the health system. The intervention group saw a reduced number of falls, while this increased in the comparator group. Falls can often be fatal: around 28% of older people died within 12 months of a fall according to the King's Fund[70], and for those who suffer a hip fracture, half "never return to their previous level of independence, and approximately 20% enter a care home"[25]. (Although these serious outcomes may be more likely to occur in already more frail older people, benefits to healthy older people are still expected to be significant.) Interestingly many of the benefits observed for this study were physical. It is difficult to know to what extent these benefits are caused by the social activity of singing, or the other elements involved, such as "cognitive (e.g. attention and memory) and physical skills (e.g. balance)"[26]. Two other studies in this area did not report significant gains in participants' physical quality of life[2627]. For a relatively small cost (£86 per person), the intervention would be expected to deliver both cost savings and improved health outcomes versus the comparator.

Further details

Measurement scales

Morale, or psychological wellbeing, was measured using the Geriatric Center Morale Scale. Values on this scale range from 0-17, where 0-9 represents low morale; 10-12 is middle range and 13-17 represents high morale (Lawton, 1975[71]).

Loneliness was analysed using the Loneliness Scale III, which measures subjective feelings of loneliness or isolation. Participants scoring over 48 were categorised as "most lonely" (Adams et al. 2004[9]). Depression was measured on the Geriatric Depression Scale (Short Form), whereby scores greater than 5 suggest the need to see a doctor (Sheikh & Yesavage, 1986[72]).

Outcomes

The table below presents the figures for changes in physical health.

Table 6: Physical health

Self-rating of overall health~		**No. of doctor visits in the past 12 months**		**No. of over the counter medications**		**Falls**		**Other health problems***	
At baseline									
I	C	I	C	I	C	I	C	I	C
7.88	7.63	5.82	7.33	2.01	2.66	0.4	0.36	0.24	0.3

At 12 months follow-up									
7.97	7.25	6.73	10.84	2.61	4.25	0.23	0.55	0.37	0.45
0.09	-0.38	0.91	3.4	0.6	1.59	-0.17	0.19	0.13	0.15
1%	-5%	16%	46%	30%	60%	-43%	53%	54%	50%

I=Intervention; C=control/counterfactual

~ 0 being worst and 10 being best

*0=no other health problems, 1= other health problems; Not statistically significant (p < .10)

Cost Calculations

The table below presents our calculations for the cost of the intervention.

Table 7: Intervention cost calculations

Input	Value	Source
No. of participants	90	Cohen et al. 2006[73]
Duration in weeks	30	
Classes per week	1	
Cost of a room with piano and tutor/1 hour accommodating 30 people	£60	Adapted from Coulton et al. 2015, based on 1/8th of day costs + £35 trainer travel costs
No. hours per session	2	Assumption, Optimity
Cost of a room with piano and tutor/2 hours accommodating 30 people	£85	Calculation (adapted from Coulton 2015)
Cost of room hire for 90 people per week	**£255**	**Calculation**
Cost of room over 30 weeks for 90 participants	**£7,650**	**Calculation**
Chorale music scores (average)	£10	Amazon
Cost of music scores for 90 participants	**£90**	**Calculation**
Total cost of room hire, teacher and music scores over 30 weeks for 90 people (intervention cost)*	**£7,740**	**Calculation**
Cost per person	**£86**	**Calculation**

*Current market prices

N.B. The cost calculations do not take into account public performances as no details of the frequency of the event were given – it is assumed there would be a cost to the programme organiser. Similarly, transport costs to participants throughout the intervention were not estimated due to a lack of information.

Cost savings from the intervention were calculated as shown below.

Table 8: Intervention cost savings

Outcome	Change	Value	Savings
Self-rating of overall health	Improved for intervention; decreased for comparator group	Not applicable	No cashable saving possible
No. of doctor visits	Increased for both but less so for intervention group	Cost of health care (GP): £3774	2.49 GP visits prevented at a value of £92.13
No. of over the counter medicines	Increased for both but less so for intervention group	Average over the counter (OTC) medication cost75 £2.40	1 OTC medication use prevented at value of £2.40

Falls	Decreased in intervention arm, increased in comparator group	See key findings table above	
Morale	Worsened in the both groups, more in the comparator	No unit cost is available	No cashable saving possible

4.3.2 Internet and computer training intervention

The table below presents key findings from the cost-consequence analysis, including a short description of the intervention, study outcomes as reported directly in the text (whereby green indicates a positive outcome; amber no difference or a non-statistically significant finding; and red indicates a negative outcome), as well as a description of consequences. We linked the results of the intervention study to another study examining the impact of increased internet usage on health and wellbeing, so additional potential consequences are also described.

More detail on how these results were calculated is shown below this table.

Table 9: Key findings

Intervention Paper (s)	White, H., McConnell, E., Clip, E., Branch, L. G., Sloane, R., Pieper, C. & Box, T. L. 2002. A randomized controlled trial of the psychosocial impact of providing internet training and access to older adults. Aging & Mental Health, 6, 213-21	
Intervention	Internet (electronic mail and the World Wide Web [WWW]) training vs. no training (individuals on a waiting list for training)	
Study design	• US • Quality score + • RCT • Follow-up: 5 months (~20 weeks) • Sample size: Intervention 48, control 45 (used for statistical analysis; does not include drop-outs) • Mean age of participants: intervention group – 71; control - 72	
Intervention description	• Basic computer operation, use of e-mail, and introduction to accessing WWW • 9 hours of group training (trained by a young college graduate) • 4-6 people per class • Intervention lasted 2 weeks • A training manual covering various topic produced specifically for this project • After the training, the trainer was available 2hrs/per week/site • At other times, by phone or e-mail • 6 sites	
Intervention cost	**Estimated at £27,060 or ~£564 per person** (N.B. Costs and results do not include dropouts who did not complete the training)	
Study outcomes	Loneliness/life satisfaction	No statistically significant difference between groups
	Depression	No statistically significant difference between groups
	Computer use	After the intervention, 51% with no prior experience started using WWW at least once a week
		After the intervention, 80% with computer experience used WWW at least once a week
Descriptive	While the intervention[28] showed no statistically significant direct impact	

consequences

on participants' loneliness/life satisfaction and depression, it appeared to boost weekly computer use. (It should be noted that this study was carried out in 2002, so it is possible that the impact on weekly computer use would be different now, although it is difficult to say to what extent and in which direction.)

However, an increase in the frequency of computer use has been linked to improvement in various wellbeing measures, as measured by Cotten and colleagues (2013)[29]. Therefore, and given the relatively short follow-up of the White study, we expect the training intervention would lead to a longer-term indirect improvement in loneliness as well as other metrics described below. (Other studies identified in the LSE Evidence Review also supported a link between internet training and decreased loneliness.)

In the scale reported in Cotten et al.[29] (where never using a computer = 0, usage once every few months = 1, once every month = 2, several times a month = 3, every week = 4, several times a week = 5), we would expect the increase in computer use from this training intervention (for those who experienced an increase) to correspond to a 4 point increase for those who had no computer use experience and at least a 1 point increase for those with prior computer experience.

The impact of a 1 point increase is shown below, as reported by Cotten et al. 2013[29]:

Outcome	Change	Scale
Decrease in loneliness	0.147	on a scale 3-9
Made it easier to reach people	0.508	on a scale 1 [strongly disagree] to 5 [strongly agree]
Contributed to stay in touch	0.516	
Made it easier to meet new people	0.297	
Increased quantity of communication with others	0.306	
Made respondent feel less isolated	0.491	
Helped to feel more connected to friends and family	0.392	
Increased the quality of communication	0.289	

Possible consequences

The internet and computer training can have potentially positive health outcomes and can possibly help to avoid the following:

- People who are the loneliest are 45% more depressed compared to 15.2% of those who are least lonely[9]
- 28% of loneliest men reported poor health compared to 5% who were not lonely[18]
- Isolation can be as harmful as smoking 15 cigarettes a day[10]
- People with a higher degree of loneliness are associated with a doubled risk of developing Alzheimer's disease[10] and is associated with higher rates of dementia more generally (this latter risk is modelled in the cost-utility analysis)
- There is a 50% increased likelihood of survival in individuals with stronger relationships[11]
- Odds ratio (OR) of loneliness (inversed) on mortality: 1.45[11]
- OR of social isolation (inversed) on mortality: 1:40[11]
- OR of social networks on mortality: 1.45[11]
- OR of social integration on mortality: 1.52[11]
- OR of complex measures of social integration: 1.91[11]

At a cost of approximately £564 per person, the intervention led to increased internet usage, which has been linked to a number of improvements in wellbeing in older people. For half of the group who had never used the internet, the intervention led to weekly usage, a 4 point improvement in the Cotten scale, which could lead to significantly

	greater benefits than those quoted above (under 'Descriptive Consequences' for a one point improvement). It should be noted that the White paper is from 2002 – more up to date research in this area has been done but this paper was chosen as it best met the criteria for this economic analysis.

Further details

Method

White and colleagues (2002) [28]assessed the effectiveness of internet training for elderly adults and presented results in terms of frequency of computer use along with other outcomes, such as depression and loneliness. However, the impact of the intervention on loneliness and depression was not statistically significant compared with the usual care group; however there was a significant increase in frequency of computer use. We included the data from Cotten et al. (2013)[29] to show the potential impact of the increase in the computer use reported in the intervention. Cotten et al. (2013) used regression analysis on baseline data from a randomized controlled trial to investigate the relationship between frequency of internet use (measured on a six point scale from never to several times a week) and variables such as loneliness, isolation and communication with others (Table 10). The diagram below shows how these outcomes are included in the analysis.

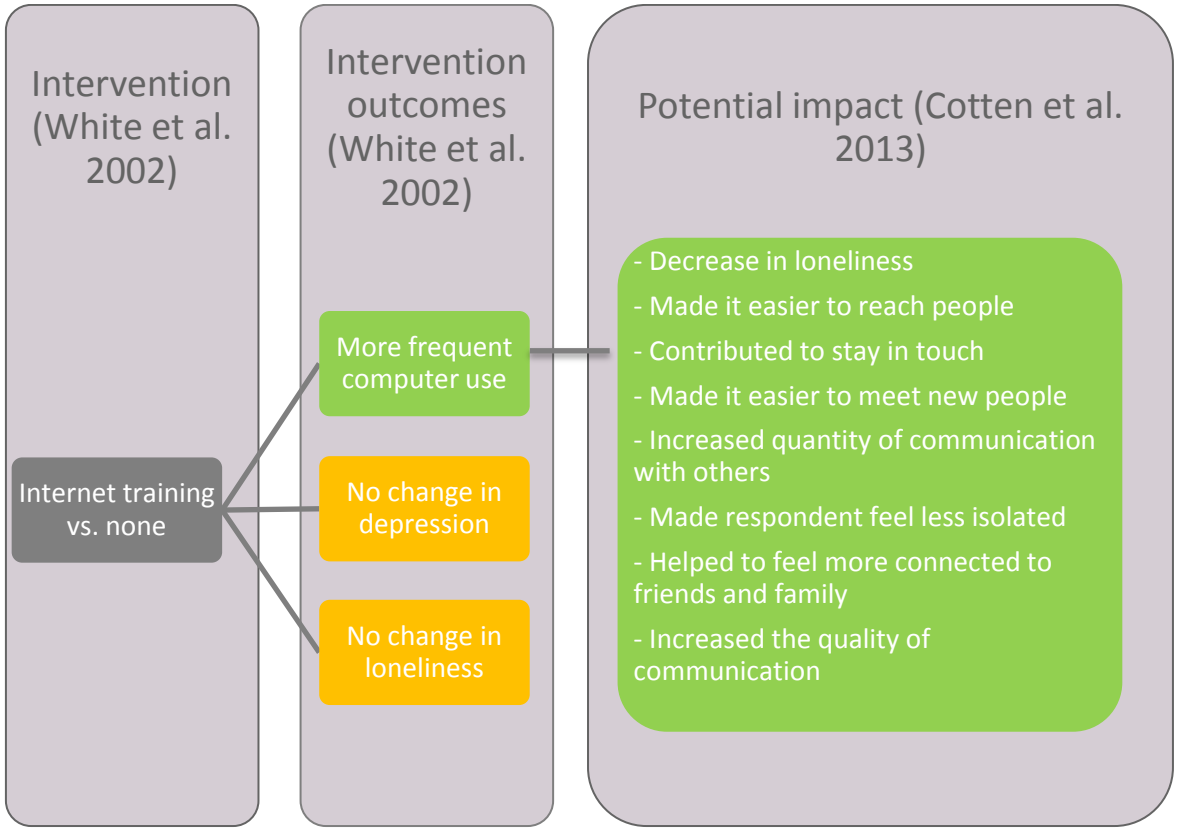


Figure 2: CCA concept

Table 10: Impact of computer use on number of outcomes

Increase in the frequency of going online by 1 point	
Impact (all numbers are statistically significant)	
Decrease in loneliness	0.147
Made it easier to reach people	0.508
Contributed to stay in touch	0.516
Made it easier to meet new people	0.297

Increased quantity of communication with others	0.306
Made respondent feel less isolated	0.491
Helped to feel more connected to friends and family	0.392
Increased the quality of communication	0.289

Other findings

As a result of computer training, White and colleagues (2002)[28] observed a number of other findings in the intervention group. These findings are summarized below:

- 60% of the total sample (including individuals who have not completed the training) have used the computer on a weekly basis;
- 74% of those who completed training where using computer on a weekly basis;
- In the intervention sample, 79% of men and 53% of women used WWW;
- In the intervention sample, 35% of women and 14% of men used e-mail;
- Persons with previous computer experience are likely to use WWW at least once a week (80%);
- Persons with previous computer experience are likely to use e-mail compared to people with no experience (47% vs. 21%);
- Self-reported health is not related to use of WWW;
- People with good to excellent health are more likely to use WWW compared to people with poor health (65% vs. 53%);
- People with good to excellent health are more likely to use e-mails compared to people with poor health (42% vs. 6%);
- People with activity limitation due to health use emails more compared to people without limitations (38% vs. 16%).

Cost calculations

The table below presents our calculations for the cost of the intervention.

Table 11: Intervention cost calculations

Input	Value	Source/notes
IBM style computers (no. of computers not specified. We assume 48 computers; one per participant)	Unit cost of a computer: £400	PC World
Total cost of 48 computers	**£19,200**	**Please note, that these computers will be useful to train other groups after 5 months; for further training no computer purchase will be necessary**
Internet	In this case was free	We assume the institutions already have Internet. If the cost of internet was included, it would cost ca.£500 for 3.4 month (internet for business)
Printer (average)	Here by donations	We assume at cost of ca. £50. In this case we assume 1 printer per site, in total 6 sites
Cost of the printers	**6 printer at cost of £50; estimated at £300**	**One printer per site**
Printer toner	£35	PC World, average price
Total cost of printer toners	**£1,050**	**5 toners (one per month), 6 printers (one per site)**

Computer room	The computer rooms was set at the institutions; we assume no additional cost of setting up	
Maintenance cost	£20/hour	http://moviba.com/pc-fix-it/personal-maintenance/pc-repair/
Total maintenance cost	**£2,400**	**Assume 1hr per week per facility (20 weeks, 6 facilities)**
Trainer (graduate)	~£15/hour	ONS, 2013[76]
Cost of trainer (9hrs)/site of 6 people	£135	Cost of 9 hours per site
Total cost of trainer for all 48 participants	£810	Cost of 9 hours for 6 sites
Developing training manual (assumed takes 4hrs of trainers time)	**£60**	**Printing and binding was assumed to be free (using printers purchased)**
Additional times trainers spent on sites (2hrs/week/site)	£180	2hrs per week at cost £30*number of sites (6)
Cost of trainer over consecutive 18 weeks (post training cost)	£3,240	Assumed for consecutive 18 weeks [total 20 weeks minus no. of training weeks (2)] (no. of sites – 6)
Total cost of trainer over 20 weeks	**£4,050**	
Other cost of trainers times, such as by phone or email	Assumed zero	
Total cost of the intervention	**£27,060**	
Cost per participant	**~£564**	
Total cost of counterfactual (waiting list control)	**£225**	**Was given a token gift (not specified); assumed at £5 per person (45 people)**

Measurement scales

The measurement scales used in White et al. 2002[28] and Cotten et al. 2013[29] are summarized in Table 12.

Table 12: Scales used to measure outcomes

Scale	Method	Range
White et al. 2002		
The UCLA Loneliness Scale	20 questions on 4 point scale	Score range: 20-80, higher scores indicating higher level of loneliness
Modified form of CES-Depressions scale	10 questions on 3 point scale	Higher scores indicating more depressive symptoms
Perceived Control of Life Situations	8 questions on 4 point scale	Score range: 8-32, higher scores indicating greater control
Attitudes towards personal computers, the WWW, and electronic mail	9 questions of a 5 point Likert scale	Score range: 9-36, lower scores indicted more favourable attitudes
A single life satisfaction item	5 questions	Categories: not satisfied to very satisfied
Average number of hours of computer use per week	N/A	N/A
Cotten et al. 2013		
The UCLA Loneliness Scale [shorter version]	3 questions on 3 point scale	Score range: 3-9, lower scores indicating better outcomes

The perceived social isolation [no name]	5 questions on 5 point scale	Mean score of 3 questions
Perceptions of computer use	7 questions with 5 point scale	Score range: 7-35, higher scores indicate better outcomes
Frequency of computer use	Scores from 0-5	0=never 1=once every few month 2=about once a month 3=several times a month 4=about once a week 5=several times a week

4.3.3 School based intergenerational activities and volunteering

The table below presents key findings from the cost-consequence analysis, including a short description of the intervention, study outcomes as reported directly in the text (whereby green indicates a positive outcome; amber no difference or a non-statistically significant finding; and red indicates a negative outcome), as well as a description of consequences.

More detail on how these results were calculated is shown below this table.

Table 13: Key findings

Intervention Paper(s)	Fujiwara, Y., Sakuma, N., Ohba, H., Nishi, M., Lee, S., Watanabe, N., Shinkai, S. 2009. REPRINTS: Effects of an intergenerational health promotion program for older adults in Japan. Journal of Intergenerational Relationships, 7, 17-39	
Intervention	Senior volunteers engaging in reading picture books to children. The REPRINTS (Research of Productivity by Intergenerational Sympathy) programme was developed to educate and engage senior volunteers in picture book reading to young and school-aged children in an educational setting	
Study design	• Conducted in Japan • Quality score + • Controlled before and after study • Sample size: 67 (intervention group), 74 (control group) • Average age: 68 • Follow-up: at 9 and 21 months (results presented for 9 months unless otherwise stated)	
Intervention description	3 months of weekly training sessions to learn about book selection and reading techniques. After the training the volunteers were divided into groups of 6-10 volunteers to visit 6 elementary schools, 3 kindergartens, and 6 child care centres for after-school children once a week or every two weeks. Average time ± standard deviation for selecting picture books was 75 ± 38 minutes, practicing or preparing for performance was 69 ± 31 minutes, and visiting schools to read picture books was 83 ± 50 minutes for one. Each volunteer chose a group mostly because of the location of the school or child care centre that the group was to visit regularly. There were meetings after reading sessions for information sharing. Groups in the same area also meet once a month. Book reading trainers and other professionals in gerontology and lifelong learning were invited to these monthly meetings.	
Total cost of the intervention	**£691 or £10 per participant**	
Value of volunteering	Value of volunteering at 21 months follow-up*	Ca. £269,973

	Value of volunteer per session	£81 [see Table 16]
Study outcomes	**Social networks (0-5 scales)**	
	Social network score: frequency of communication with friends and neighbours	Not statistically significantly different among groups
	Social network score: frequency of communication with distant children (non-related, in volunteer programs or events)	Increased by 106% in intervention arm (1.6 – 3.3) vs. slight decline in control (1.6 – 1.4) Rose to ~3.8-4 in intervention group at 21 month follow up, although also rose in control group after 21 months (to 1.7)
	Social network score: frequency of communication with grandchildren	Significant group x time effect; increase in intervention arm, decrease in control arm: 2.1 – 2.4 vs. 2.7 – 2.4
	Social network score: frequency of communication with neighbourhood children	Not statistically significantly different among groups
	Social network score: number of persons – friends or neighbours	Increased significantly over time in intervention arm but not statistically significantly different among groups I: 1.9 – 2.2; C: 2.1 – 2.1
	Social network score: number of persons – distant friends	Significant group x time effect; increase in intervention arm, decrease in control arm: 3.1-3.5 vs. 3.3 – 3.2
	Receiving social support (4 x 0-5 scales, i.e. assumed 0-20)	
	Receiving social support from family members living together	Not statistically significantly different among groups
	Receiving social support from family members living apart	Not statistically significantly different among groups
	Receiving social support from friends and neighbours	Decreased in the intervention group (11%), increased in the control (5%) Intervention: 9.9 to 8.8 Controls: 10.5 to 11.0
	Providing social support (4 x 0-5 scales, i.e. assumed 0-20)	
	Providing social support from family members living together	Not statistically significantly different among groups
	Providing social support to family members living apart	Not statistically significantly different among groups
	Providing social support to friends or neighbours	Significant group x time effect; increase in intervention arm, no change in control I: 11.2 – 13.1; C: 12.7 – 12.7
	Social activity score (scale not given)	
	Social activity score - social or volunteer activity	Significant group x time effect; increase in both arms but more so in intervention arm I: 3.6 – 4.1; C: 3.5- 3.9 14% vs. 11%
	Social activity score – personal activity	Not statistically significantly different among groups
	Social activity score – lifelong study	Not statistically significantly different among groups
	Social activity score - occupation	Not statistically significantly different among groups
	Self-rated health & other health outcomes	
	Self-rated health (measured as excellent, good, fair and poor)	Significant group x time effect; increase in intervention arm, decrease in control arm. I: 1.9 - 2.1; C 2.1-2.0 +10% vs. -5%

		Further increase at 21 months in I arm, to ~2.25 (+18% from baseline)
	Usual walking speed m/minute:	Not statistically significantly different among groups
	Hand grip, kg	Significant group x time effect; decrease in both arms but less so for intervention group. I: 25.7 – 25.4; C 26.6 – 25.1
Other possible consequences	• Men with the smallest social networks were found to be at significantly higher risk of death than women with larger social networks (Hazard Ratio: 4)[77] • The risk of death for subjects based on Social Network Index (SNI) is only significant in the comparison between SNI III [being integrated] and SNI I [being most isolated] (HR 0.67)**[77] • Odds ratio (OR) of received social support on mortality: 1.22[11] Overall, the intervention delivered greater benefits than its cost in terms of the value of volunteering, while also improving some social intergenerational outcomes, particularly around connecting with distant children; self-rated health and providing social support, which are likely to improve mortality outcomes. However, received support from friends declined significantly, which could have an adverse effect on mortality. The authors noted "pride may have been a factor that prevented [participants] from accepting social support." Finally, we must raise the issue of transferability of results from Japan to the UK.	

*The calculation of value of volunteers is based on the methodology of the Institute for Volunteering Research Volunteer Investment and Value Audit (VIVA) tool[7879]. It is assumed that if elderly did not volunteer, then the intervention would be delivered by teachers (equivalent paid job).
**The SNI is measured on a scale I-IV; I being most isolated; IV being most integrated (Keller et al. 2003[77])

Further details

Measures

A number of measures were adopted by Fujiwara and colleagues (2009)[30] to explore the impact of school based intergenerational activities on elderly volunteers. The measures used in the research are summarized below.

Physical health conditions

The authors measured physical health conditions of the participants; their medication history, presence of chronic conditions, their hearing, visual and chewing abilities.

Functional capacity

Functional capacity was assessed using the Tokyo Metropolitan Institute of Gerontology (TMIG) Index of Competence (TMIC). The TMIC Index is 13-item index of competence scale that measures self-maintenance, intellectual capacity and social role. The maximum score of 13 indicates better functional capacity.

Subjective health status and psychological health

The self-rated health was measured as: excellent, good, fair and poor (scale is not presented/described). Depressive symptoms was assessed against the short version of Geriatric Depression Scale (GDS) (Niino,

1991[80]). Level of self-esteem was measured by Rosenberg's 10 item scale (Rosenberg, 1979[81]). In addition, Locus of Control (LOC) was used. The LOC scores range from 18 to 72, where higher scores indicate more internal tendency (Kambara, 1982[82]).

Social participation

Social activity checklist was used for self-evaluation of social activity, based on Takahashi et al. 2000[83], but the scale was not given, and the original paper is in Japanese.

Social network, social support and cognitive function

Amount of daily contact was assessed too (social network). Social network was assessed by to the amount of daily contact and grouped by 0, 1-4 persons, 5-9 persons, 10-19 persons, 20-49 persons, 50 persons and over and scored 0-5 respectively. Frequency of contact was also recorded as a 0-5 score based on the following categories: never, less than once a month, a few times a month, once a week, twice a week or more. Social support was measured by a 4 item scale (Noguchi, 1991[84]), referring to the questions; "To what degree does the person listen to your private worries and fears?"; "To what degree is the person caring for you?"; "To what degree can you ask some help in a daily life to the person?" and "To what degree does the person provide care when you are sick in bed for several days?". The scoring was 0-5 for each type based on the categories 'not applicable', 'never', 'not so well', 'so-so', 'well' and 'very well'. We assume this was aggregated into a 0-20 score for social support. Cognitive function was tested by suing memory test "Story Recall" (Watamori, 2002[85]).

Physical performance test

Speed of walking, one-leg duration test, grip strength and elaboration of fingers was measured.

Outcomes

The intervention outcomes were measured on multiple scales. The effect of the intervention on these scales is presented below.

Table 14: Results at 9 months follow-up (all numbers are statistically significant)

Measure	Volunteers			Controls		
	Baseline	Follow-up	Change	Baseline	Follow-up	Change
Social network scale: frequency of communication with distant children	1.6	3.3	1.7 (106%)	1.6	1.4	-0.2 (-13%)
Social network scale: frequency of communication with distant friends	3.1	3.5	0.4 (13%)	3.3	3.2	-0.1 (-3%)
Receiving social support score from friends or neighbours	9.9	8.8	-1.1 (-11%)	10.5	11.0	0.5 (-5%)
Social activity score: social or volunteer activity	3.6	4.1	0.5 (14%)	3.5	3.9	0.4 (11%)
Usual walking speed, m/minute	86.9	92.1	5.2 (6%)	81.0	88.2	7.2 (9%)
Hand grip strength, kg	25.7	25.4	-0.3 (1%)	26.6	25.1	-1.5 (6%)

Negative numbers indicate negative change

Self-rated health has improved among volunteering group from 1.9 to 2.1 at 9 month, and to ~2.2 at 21 months. Self-rated health has declined for the control group from 2.1 at the baseline to 2.0 at 9 and 21 months. (No scale for self-rated health is presented, other than a grade of excellent, good, fair or poor.)

Transition of frequency of interchange with children in the intervention has increased from 1.6 to 3.3 at 9 months and ~3.8-4 at 21 months. In the control group, transition of frequency of interchange with children has declined from 1.6 to 1.4 at 9 months and has increased again at 21 months to 1.7.

At 21 month follow up effect of physical performance on volunteers has reduced in value (figures not presented). Authors argue that the effect attenuation could be because both groups were healthy and active at baseline and maintained good scores during 21 months.

Changes on the GDS or any other scales are not reported.

Cost calculations

Table 15: Cost calculations

Input	Value	Source
No. of training sessions (weekly training session)	12	Fujiwara, 2009
Duration of the training session	2hrs	Assumption, Optimity
Training room cost	0	Assuming using school rooms after teaching hours (Optimity)
Cost of transportation	0	Assuming schools are located within close walking distance
Cost of trainers time (delivered by teachers at schools, kindergartens and child care centres)/hr	£21.33	Primary and nursery education teaching professionals, mean wage, 2014[78]
Cost of training per session	£42.66	Teachers time*2
Cost of 3 month weekly training delivered by a teacher	**£512**	**Assumed 12 weeks; assumed all 67 participants were trained at one facility as no training details are given**
Cost of other professionals time (mean hourly pay), 2014	£29.81	Assumed cost of senior professionals of educational establishments (once a month, for 3 month)
Cost of professionals time for 3 months	**£179**	**One session per month (assumed 2hrs each)**
Total cost of the training (intervention)	**£691 or £10 per participant**	**Assumes delivery by one teacher for all 67 participants**

We assume there will not be additional cost such as transportation, as volunteers live close to school. We assume that books will be provided by schools or borrowed from libraries at no additional cost.

To assess the value of volunteering, we employed the Institute for Volunteering Research Volunteer Investment and Value Audit (VIVA) tool[8687].

Table 16: Value of volunteering

Value of volunteering		
Volunteer role/title	Reading picture books to students	Fujiwara, 2009
Equivalent paid job	Primary and nursery education teaching professionals	Fujiwara, 2009
Hourly wage in equivalent paid job	£21.33[Error! Bookmark not defined.]	ONS, 2014
Total weekly hours	227 minutes (~3.8hrs)	Fujiwara, 2009
Value of one volunteer per week (per session)	**£81**	**Calculation**
At 9 months		
No. Of people volunteering once a week	39	From total of 67, only 56 continued

No. Of people volunteering once a month	17	volunteering at 9 months (Fujiwara, 2009)
No. Of weeks in 9 months	36	
Value of volunteering for 36 weeks, one volunteer	£2,916	Per volunteer
Value of volunteering for 36 weeks, 39 volunteers	**£113,724**	39 volunteers
Value of volunteering (once a month) for 9 months, one volunteer	£729	Per volunteer
Value of volunteering for 9 month (once a month), 17 volunteers	£12,393	17 volunteers
Total value of volunteering at 9 months (56 volunteers)	**£126,117**	**Calculation**
At 21 months		
No. Of people volunteering once a week	37	Fujiwara, 2009
No. Of people volunteering once a month	16	Fujiwara, 2009
No. Of weeks in 12 months	48	
Value of volunteering: 37 volunteers for 48 weeks (one session per week)	**£143,856**	
Value of volunteering: 16 volunteers for 48 weeks (one session per month)	**£15,552**	**Calculation**
Total value of volunteering in 12 months (53 volunteers)	**£143,856**	**Calculation**
Total value of volunteering at 21 months follow up	**£269,973**	**Calculation**

4.3.4 Friendship programmes

The table below presents key findings from the cost-consequence analysis, including a short description of the intervention, study outcomes as reported directly in the text (whereby green indicates a positive outcome; amber no difference or a non-statistically significant finding; and red indicates a negative outcome), as well as a description of consequences.

More detail on how these results were calculated is shown below this table.

Table 17: Key findings

Intervention Paper (s)	Martina, C. M. S. & Stevens, N. L. 2006. Breaking the cycle of loneliness? Psychological effects of a friendship enrichment program for older women. Aging & Mental Health, 10, 467-475 Martina, C. M. S., Stevens, N. L. & Westerhof, G. J. 2012. Promotion of self-management in friendship. Aging & Mental Health, 16, 245-253
Intervention	Friendship enrichment programme targeting older women
Study design	*Martina et al. 2006*[31] *& 2012*[32] Conducted in the Netherlands Quality score + Quasi-experimental study Mean age: 63 Sample size: 60 (intervention), 55 (control – waiting list)
Intervention description	*Martina et al. 2006* [31] *& 2012*[32] Friendship enrichment programme lessons focusing on topics related to

	friendship Recruitment through local newspaper articles and distribution of folders describing the programme 12 lessons (weekly) 6 groups Data collection: at baseline, at 3 month, at 9 month after baseline €12.50 voucher as token at the end of each interview (face-to-face) Response rate 82%	
Intervention cost	Total cost of recruitment, training, baseline interview and token: £4,626 or £77 per head Total cost of recruitment, training, baseline, follow-up interviews (3 in total) and tokens: £7,190 or £120 per head	
Study outcomes	*Martina et al. 2006*[31]	
	Friendships	
	Loss of friendships	Deterioration and loss of friendships was observed in the both groups but the difference was not statistically significant
	Improvements in friendships	62% of the intervention group reported improvements in their existing friendships compared to 46% in the control group; the difference was not statistically significant
	Increased friendships	At six months, 63% of the friendship enrichment group reported that they made new friends through social and educational activities vs. 33% in the control group
	Contact with friends	At six month, 55% of the friendship enrichment group reported that they still had contact with other women from the programme
	Increased no. of friends	15% of participants in the friendship enrichment group named no friends in their convoy but, at 6 months, this proportion was reduced to 5%. In the control group, the proportion increased from 0% to 5%.
	Self-esteem, well-being and loneliness	
	Positive affect [PA] (high PA - state of high energy, full concentration, and pleasurable engagement; low PA – sadness, lethargy)	No statistically significant difference between groups.
	Negative affect (general dimension of subjective distress and unpleasant engagement)	Improved in the intervention group by 6% and 4% at 3 and 9 months respectively; worsened in the control arm by 3% at 3 months and by -13% at 9 months
	Self-esteem	Improved by 5-7% in the intervention group and by 0.1-0.2% in the control group
	Life satisfaction	Improved in the intervention group by 4% at 3 months and by 8% at 9 months; worsened in the control group (1-3%)
	Loneliness	Improved by 4% at 3 months and by 11% at 9 months in the intervention group. In the control group loneliness decreased by 3% at 3 months and by 5% at 9 months follow-up. (N.B. Although the change over time in the intervention group was significant, and in the control group was not, the between group comparison of decline was not significant)
	Martina et al. 2012[32]	
	Self-management in friendship	
	Self-efficacy	Impersonal orientation improved by 2% at 3 months in the intervention arm, and worsened by 4% in the

		control arm. At 9 months, the rate had decreased by 1% compared to the baseline rate in the intervention group but the decrease was higher in the control group at 4%.
	Taking initiative	No statistically significant difference between groups
	Multifunctionality of resources	No statistically significant difference between groups
Descriptive consequences	According to Lacruz et al. 2011[88], among an elderly German cohort, the absolute mortality risk for high LS was 67/10,000; for medium LS was 98/10,000; and for low LS was 140/10,000. High LS is associated with survival in men (Hazard Ratio 0.55) but, not in women. People with higher life satisfaction made fewer doctor visits, relative risk=0.96 (adjusted for various sociodemographic, psychosocial, and health-related covariates). One unit increase in life satisfaction (reported on the Satisfaction with Life Scale [Diener et al, 1985[61]; Pavot and Diener 1993[89]] was associated with a 3.6% (adjusted) reduction in the number of reported doctor visits. The most satisfied participants made 18.46% (adjusted) fewer doctor visits compared to the least satisfied. Subgroup analyses showed that life satisfaction was associated with frequency of doctor visits only in the high life satisfaction group (RR = 0.91). In contrast, life satisfaction was not associated with frequency of doctor visits in the low life satisfaction group (RR = 1.03) [adjusted for age, sex, race/ethnicity, marital status, education level, and total wealth][90]. Another survey in the UK found that the mean quality of life score for those classified as lonely was lower than the national average (0.604 vs. 0.780)[18]. Overall, for a maximum cost of £120 the intervention led to improved outcomes for friendships, life satisfaction, loneliness, and self-efficacy which would be expected to result in higher quality of life and lower mortality risk. Finally, it should be noted that this programme was run for women only, so results may not apply to men.	

Table 18: Study outcomes (Martina et al. 2006)

Self-esteem		**Life satisfaction**		**Negative affect**		**Loneliness**	
Martina et al. 2006							
At baseline							
I	C	I	C	I	C	I	C
32.31	37.53	14.08	17.34	29.46	25.98	7.49	4.96
At 3 months (after the first measurement or when directly after the programme)							
I	C	I	C	I	C	I	C
33.86	37.62	14.71	17.15	27.64	25.20	7.17	4.82
-1.55	-0.09	-0.63	0.19	1.82	0.78	0.32	0.14
-5%	**-0.2%**	**-4%**	**1%**	**6%**	**3%**	**4%**	**3%**
At 9 months (6 months after the programme finished)							
I	C	I	C	I	C	I	C
34.56	37.56	15.19	16.84	28.14	29.25	6.63	4.71
-2.25	-0.03	-1.11	0.5	1.32	3.27	0.86	0.25
-7%	**-0.1%**	**-8%**	**3%**	**4%**	**13%**	**11%**	**5%**

I= intervention group

C=control group

Table 19: Study outcomes (Martina et al. 2012)

Impersonal orientation	
Martina et al. 2012	
At baseline	
I	C

12.02	10.62
At 3 months (after the first measurement or when directly after the programme)	
I	C
12.30	10.20
-0.28	0.42
-2%	4%
At 9 months (6 months after the programme finished)	
I	C
11.86	10.22
0.16	0.4
1%	4%

I= intervention group

C=control group

Negative numbers indicate negative change

Table 20: Measurement scales

Scale	Measurement	Scores
Martina et al. 2006		
Assertiveness scale (Brinkman, 1977)	Self-esteem	10-50; higher scores indicate more positive view of one's self
Gierveld & Tilburg loneliness scale (Gierveld & Tilburg, 1999)	Loneliness	0-11; higher scores indicate more loneliness (3-8 moderate loneliness; 9+ severe loneliness)
Satisfaction with Life Scale (Pavot & Diener, 1993)	Subjective well-being	5-25 higher scores indicate higher level of satisfaction with life
Positive and Negative Affect Scale (PANAS)	Subjective well-being	Measures positive affect and negative affect suing 20 items. High PA reflects better subjective well-being; Low NA reflects better subjective well-being
Martina et al. 2012		
Orientation in Friendship scale	Self-efficacy (autonomy, control, impersonal orientation)	3 subscales measured on a 4 point scale (1=not characteristic at all, 4=very characteristic) [no more details]
Taking initiative	Ability to take initiative in social relationships	35 items [no more details]
Multifunctionality of resources	Social support in relationship	10 items; scores 10-30 [no more details]

Table 21: Cost calculations

Input	Value	Source
Training costs		
Cost of advert in a local press	£340	http://startups.co.uk/using-a-local-newspaper-to-find-employees-for-your-start-up/
No. of adverts	2	Assumption [no details are given in Marina 2006/12]
Cost of recruitment	**£680**	**Calculation**
No. of participants	60	Martina 2006/2012
No. of sessions	12	Martina 2006/2012
No. of groups	6	Martina 2006/2012
Trainer cost/hour (mean)	£16.35	Social and humanities scientists[Error! Bookmark not defined.]
Cost of training per week/per group (group of 10 women)	~£33	Assumed 2hrs session each weeks
Cost of training of one group for 12 weeks	£396	Calculation
Cost of training for 12 week,	**£2,376**	**Calculation**

6 groups		
No. of face-to-face interviews	3 times during the study duration	Martina 2006/2012
Baseline interviews		
No. of face-to-face interviews at baseline	60	Martina 2006/2012
Duration of one face-to-face interview	1 hour	Assumption
Total hrs spent on face-to-face interview at baseline	60 hours	1hr/person
Cost of an interviewer per hour	£16.35[Error! Bookmark not defined.]	Social and humanities scientists (same rate as trainers)
Cost of baseline interviews	**£981**	**Calculation**
Token of €12.50 At baseline	**£589 (€750)**	**Calculation (€12.5 for 60 participants)**
Total cost of recruitment and training of 60 participants for 12 months	**£3,056 (or £51 per head)**	**Calculation**
Total cost of the intervention (including recruitment, training, 1 interview and €12.50 token)	**£4,626 or £77 per head**	**Calculation**
Follow-up interviews		
Response rate	82%	Martina 2006/2012
No. of people taking part in interviews	49	Calculation
Total hrs spent on face-to-face interview	49 hours	Calculation
Cos to follow-up interview 1 (3 months)	**£801**	**Calculation**
Cost of follow-up interview 1 (9 months)	**£801**	**Calculation**
Total cost of 2 follow-up interviews	**£1,602**	**Calculation**
Incentives (€12.50 token at each interview)		
At follow-up interview 1	€613	Calculation (€12.5 for 49 participants)
At follow-up interview 1	€613	Calculation (€12.5 for 49 participants)
Total cost of tokens	**€1,226 (£962[91])**	**Calculation**
Total cost of interviews and tokens at 9 months	**£2,564**	**Calculation**
Total cost of intervention including training, follow-up interviews and tokens	**£7,190 or £120 per head**	**Calculation**

5.0 Cost-Utility Analysis

5.1 Analysis methodology

As well as the cost-consequence analysis, we produced a cost-utility 'sub-analysis' for interventions that report outcomes in terms of loneliness. The rationale for this was twofold: compared to independence and mental wellbeing, the impact of a change in loneliness on health outcomes such as depression and dementia has been more rigorously established; and producing a sub-analysis of cost-utility allows the establishment of QALY gains (QALYs are a measure of quality of life over time, described below) and a cost per QALY metric, in line with other NICE guidance and methods[92].

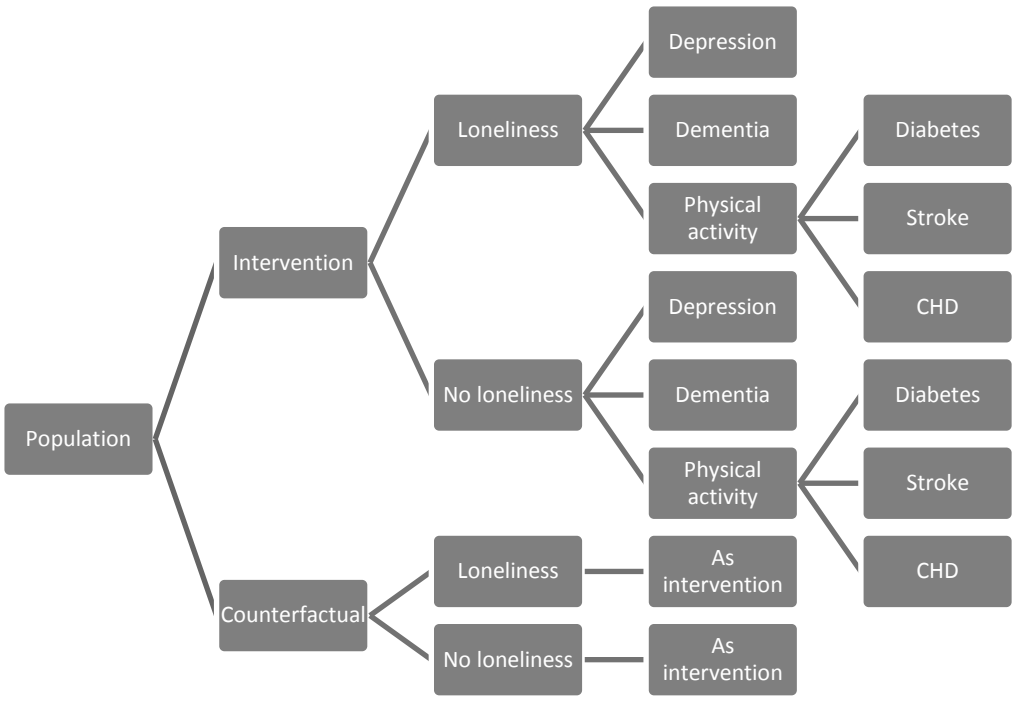
It must be noted, however, that QALY estimates produced from the cost-utility analysis (CUA) provide only a limited view of the overall impact of each intervention, given that only loneliness outcomes are included, and the model focuses only on health outcomes of loneliness (as opposed to social network or mental capacity outcomes, for instance). The CUA is intended to complement the CCA, which discusses a wider variety of outcomes.

Quality-adjusted life years (QALYs)

"A measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to 1 year of life in perfect health.
QALYs are calculated by estimating the years of life remaining for a patient following a particular treatment or intervention and weighting each year with a quality of life score (on a zero to 1 scale). It is often measured in terms of the person's ability to perform the activities of daily life, freedom from pain and mental disturbance."[93]

In order to conduct the cost-utility analysis, an Excel model was built according to the below structure:

Figure 3: CUA Model Structure



The model shows the impact of the intervention on loneliness through this structure. A given population receives either the intervention or the counterfactual (in reality, this is the control group, i.e. an estimate of what would have happened had the intervention not taken place).

The lines henceforth represent probabilities. The probability of being lonely or not being lonely is included for both the intervention and the counterfactual. A threshold approach to loneliness has been used (i.e. an individual can either be lonely or not lonely) due to the availability of data – figures on impact generally categorise levels of loneliness – although this is naturally a simplification. The intervention papers tended to report a percentage or numerical (point) improvement in loneliness, so this was converted to percentage of individuals crossing a threshold by assuming a specific distribution of loneliness scores from available data.

The probabilities of subsequent health outcomes – depression, dementia and physical activity – depend on whether an individual is lonely or not lonely. For physical activity, the probability of stroke, CHD (Coronary Heart Disease) and diabetes are also included, and changes according to whether an individual is physically active or not.

It is important to note that these do not necessarily represent the only outcomes affected by a change in loneliness – rather, we selected only outcomes where statistical evidence was available, and only health outcomes. Other health and non-health outcomes associated with loneliness were not included in this model (as opposed to the CCA).

Together, these probabilities determine changes in the health outcomes according to changes in loneliness brought on by the intervention, and a comparison with the counterfactual is made.

By putting costs to the intervention and the counterfactual, as well as the costs of treating health outcomes, and QALY values to the health outcomes, a cost per QALY can be calculated. Given that some costs and health benefits occur in the future, the model takes into account time (benefits for each disease occur up to the average age of death due to that disease, starting at the mean age of participants in each study, with the exception of dementia for which a one year time horizon is assumed), and discounts future values by a given rate (1.5%, as recommended in the NICE public health methods guidance[92]) to incorporate the fact that a given benefit in the future is valued lower than the same benefit now. The model takes a public sector perspective for benefits (benefits are in the form of patient quality of life improvements and reduced health and social care service costs), although given that the interventions were not necessarily funded by the public sector, all costs to society of the interventions themselves are included.

More detail on the model parameters (data points) and calculations is given below:

Table 22: Model Parameters

Parameter	Explanation
Age of participants	Average age of the participants in the intervention
Cost of the intervention per person	Taken from the calculation made in the cost-consequence analysis. Represents incremental cost over the counterfactual, so comparator costs are subtracted if they are not zero
Incremental effect of the intervention: reduction in loneliness	The probability of being 'not lonely' in the intervention minus the probability of being 'not lonely' in the counterfactual. This equates to the proportion of people moving from lonely to not lonely as a result of the intervention (or vice versa if negative)
Incremental prevalence of depression if lonely	The probability of depression given 'lonely' minus the probability of depression given 'not lonely'. Equates to the impact of loneliness on depression
Incremental prevalence of dementia if lonely	As above, for dementia
Incremental prevalence of not being physically active	As above, for lack of physical activity

if lonely	
Incremental prevalence of diabetes if not physically active	The probability of diabetes given a lack of physical activity minus the probability of diabetes given physical activity. Equates to the impact of not being physically active on diabetes
Incremental prevalence of stroke if not physically active	As above, for stroke
Incremental prevalence of CHD if not physically active	As above, for CHD
Annual cost of depression per case	The cost to the health service of treating one person with depression for a year (including 'non-cashable' costs such as nurse or doctor time)
Annual cost of dementia per case	As above, for dementia
Annual cost of diabetes per case	As above, for diabetes
Annual cost of stroke per case	As above, for stroke
Annual cost of CHD per case	As above, for CHD
Utility of healthy older person	Health utility is a scale of 0-1, where 1 is perfect health and 0 is death. This value represents the utility of an average older person with no major health problems
Utility of older person with depression	The utility of an average older person with depression
Utility of older person with dementia	As above, for dementia
Utility of older person with diabetes	As above, for diabetes
Utility of older person who suffers a stroke	As above, for stroke
Utility of older person with CHD	As above, for CHD
Annual discount rate	The rate applied to discount each future year
Start age of benefit for avoiding each of depression, dementia, diabetes, stroke and CHD	'Benefit' in this case applies to the avoidance of a disease. For example, the start age of benefit for avoiding diabetes equates to the age at which the individual would have developed diabetes had their risk not been reduced
End age of benefit for avoiding each of depression, dementia, diabetes, stroke and CHD	Similar to the above, this is the end age of benefit, i.e. the age at which the benefit is no longer maintained, either because the individual whose risk was reduced develops the disease anyway or would have recovered even with a higher risk. Together, the start and end age are used to calculate the time period of benefit. In order to deliver a conservative estimate in the absence of long-term data on maintenance of benefits, mortality has not been included in the model.

By multiplying out contingent probabilities, the benefit of the intervention in terms of reducing disease can be established. For example, if the incremental effect of the intervention is 5% (i.e. 5% more people are 'not lonely' in the intervention arm compared to the counterfactual) and the incremental prevalence of depression given loneliness is 2%, then the intervention leads to a 5% x 2% = 0.1% reduction in depression. (So if 1,000 people were given the intervention, one case of depression would be avoided.)

The start age and end age show the length of time for which that benefit is sustained, and also how far in the future (given that we include the average age of the participant at the time of the intervention). These figures are used to calculate the total cost from the annual cost. By multiplying this total discounted cost by the 0.1% reduction in depression, the cost savings per participant of avoiding depression is calculated. Summing these disease costs avoided for each of depression, dementia, diabetes, stroke and CHD gives the total costs saved per person.

QALY gains are calculated in much the same way, although to convert the utility figures for each disease into the utility gain from avoiding the disease, they must be subtracted from the utility of a healthy individual.

The model calculates the following results:

Table 23: Model Results

Parameter	Explanation
Cost savings per person	Total discounted cost of each disease, multiplied by the probability of avoiding it, and summed for all diseases to show the disease costs avoided per person.
Net present value per person	Cost savings minus intervention cost – represents the total money saved through the intervention (or its net cost if negative)
Benefit:cost ratio	Cost savings divided by intervention cost, i.e. the savings to the health service per each £1 spent on the intervention
Total QALYs gained per person	QALY gains from avoiding each disease, multiplied by the probability of avoiding it, and summed for all diseases to show average QALY gain per person
ICER (Incremental Cost-Effectiveness Ratio)	Cost per QALY, i.e. the cost of gaining 1 QALY. Cost in this case is the net cost (intervention cost minus cost savings)

5.2 Results

The model parameters not related to a specific intervention were populated as follows:

Table 24: General model parameters (populated)

Parameter	Value	Explanation & Source
Incremental prevalence of depression if lonely	0.32	An average of three figures. • Beach & Bamford (2014)[18] report a prevalence of depression if not lonely of 0.06, and a prevalence if lonely of 0.26, giving a difference of 0.2. • Adams (2004)[9] report prevalence of 0.15 and 0.45 for the not lonely and lonely, respectively, with a difference of 0.3. • From Heikkinen (2004)[6] a difference of 0.47 in the prevalence of depression between lonely and not lonely groups was calculated (0.66 – 0.2). (Calculation details given in the appendix.) (N.B. Beach & Bamford measures isolation as opposed to loneliness, which is a distinct but similar concept (one can be lonely but not isolated and vice versa). However, as a similar concept with a similar – slightly lower – figure than the other two papers, it was also included.)
Incremental prevalence of dementia if lonely	0.07	Calculated from Wilson (2007)[7]. Relative risk was calculated as 1.92, overall prevalence as 0.1 and the proportion not lonely as 0.631. From this, an incremental prevalence of 0.07 (0.14 – 0.07) was calculated. (Calculation details given in appendix.) The model does not assume that not being lonely reduces one's risk of dementia overall. Rather, it is assumed that it can delay the onset of dementia, and to be conservative this is assumed to be a reduction in the time one spends with mild dementia (and all else is held equal).
Incremental prevalence of not being physically active if lonely	0.6	Calculated form Hawkley (2009)[94]. Relative risk was given as 0.37, overall prevalence as 0.89 and the proportion not lonely as 0.902. From this, an incremental prevalence of -0.6 (0.35 – 0.95) was calculated, equating to the incremental prevalence of being physically active if lonely. Thus, the incremental prevalence of *not* being physically active if lonely is +0.6.
Incremental prevalence of diabetes if not physically active	0.07	Taken from Marsh et al (2011)[95]
Incremental prevalence of stroke if not physically active	0.08	
Incremental prevalence of CHD if not physically active	0.14	
Annual cost of depression per case	£1,485	The cost of treating depression from the Kings Fund[96], adjusted to 2013 prices with the GDP Deflator (latest available), and weighted by 0.62, which is the proportion of people with depression who access health services[97]
Annual cost of dementia per case	£32,574	Calculated from the Alzheimers' Society's 2007 report on dementia in the UK[98] by summing health and social care costs. Inflated to 2013 prices
Annual cost of diabetes per case	£1,191	BHF National Centre (2012)[99] – inflated to 2013 prices
Annual cost of	£31,838	

stroke per case		
Annual cost of CHD per case	£4,706	NICE (2012)[100] – cost of treatment (CHD 1st event and post first event), inflated to 2013 prices
Utility of healthy older person	1	Assumed to be 1 for base case analysis
Utility of older person with depression	0.57	Average of severe, moderate and mild (Revicki & Wood, 1998).[101] A more conservative estimate of the utility loss from depression was tested and had no major effect on results.
Utility of older person with dementia	0.63	Average of two figures for mild dementia,, from Andersen 2004[102] (0.641) and Ekman 2007[103] (0.62)
Utility of older person with diabetes	0.785	Diabetes without complications, from Beaudet 2014[104]
Utility of older person who suffers a stroke	0.73	Mean EQ-5D, from Haacke 2005[105]
Utility of older person with CHD	0.62	Marsh (2011)[95]
Annual discount rate	1.5%	Recommended by NICE
Start and end age of benefit for depression	Start set at age of participants, lasts for 5 years	5 year timeframe chosen as assumption because Heikkinen (2004)[6] has a 5 year follow up period. Depression in the elderly has a 38% recurrence rate following treatment in the community after 5 years
Start and end age of benefit for dementia	Start set at age of participants, lasts for 1 year	To be conservative, assume only a one year delay in the onset of dementia
Start and end age of benefit for diabetes	55-79	55 = average age of onset of type II diabetes 79 = average age of death due to type II diabetes
Start and end age of benefit for stroke	70-72	70 = average age of onset for stroke 72 = average age of death due to stroke
Start and end age of benefit for CHD	70-78	70 = average age of onset for CHD 78 = average age of death due to CHD

Interventions were included in the cost-utility model if they reported significant effects on loneliness. Two of the four interventions did, the internet and computer training intervention and the friendship intervention. (The singing intervention reported no statistically significant effect on loneliness.)

5.2.1 Internet and computer training intervention

The following information was included in the model for this intervention:

Table 25: Internet & computer training model parameters

Parameter	Value	Explanation & Source
Average of age of participants	71	White et al 2002[28] (the intervention paper)
Cost of the intervention per person	£564	Calculation from the CCA
Incremental effect of the intervention: reduction in loneliness	0.02	Described below

The incremental effect of the intervention was calculated using the White paper's reported impact on internet usage, fed into the Cotten et al. (2013)[29] paper's reported impacts of internet usage on loneliness.

Of the intervention participants in the White paper, 69% had no previous experience using the internet, and the remaining 31% had some. Of the former group, 51% became weekly users, which is a 4 point increase

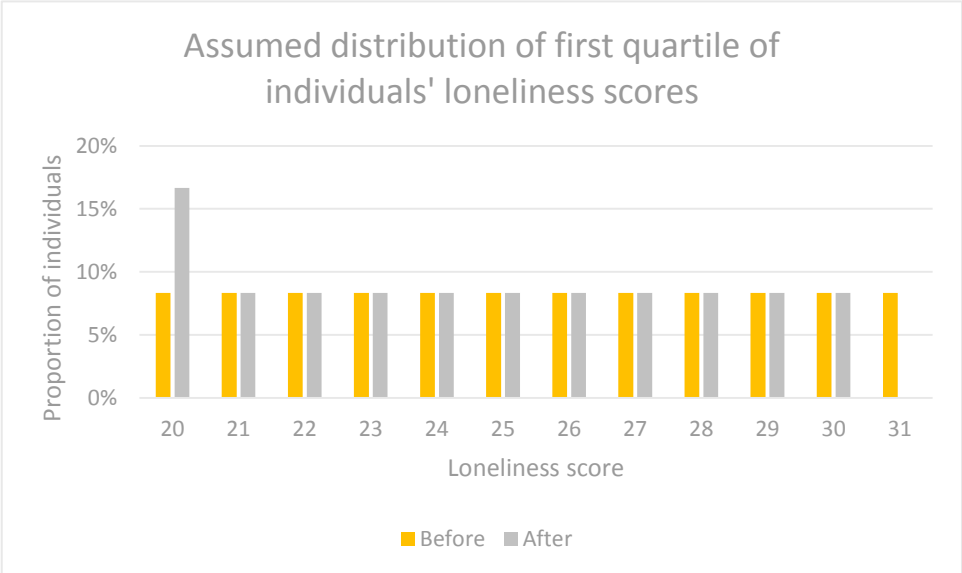
according to Cotten's scale ((where never using a computer = 0, usage once every few months = 1, once every month = 2, several times a month = 3, every week = 4, several times a week = 5). Of the latter group, 80% became weekly users – to be conservative, we have assumed this is a 1 point increase on the Cotten scale. Weighting these figures results in an average 1.66 increase in computer usage per person.

Cotten reports that a 1 point increase in computer usage results in a 0.147 decrease in loneliness on the 3 part scale reported in the CCA (values 3-9). We multiplied this by 1.66 (assuming a linear relationship between computer usage and loneliness, in the absence of other data) and then adjusted this to the UCLA Loneliness scale on which White measured loneliness, by assuming 3-9 corresponds proportionately to 20-60. This gave a 1.62 decrease in loneliness in the UCLA scale.

The baseline loneliness values reported by White show a median loneliness value of 35, with an interquartile range of 31-49. To link scores to levels of loneliness, we used the questions asked in the Cotten scale, which the authors describe as a three-item version of the UCLA Loneliness Scale. On the full UCLA scale and Cotton's three-item variant, a higher score reflects greater dissatisfaction with social relationships. The three items used by Cotton et al. (2003) were "how often do you feel that you lack companionship?"; "how often do you feel left out?" and "how often do you feel isolated from others?" A score of 1 represented "hardly ever", 2 represented "some of the time" and 3 "often". Given this, we assumed achieving a score of 4 or below represented being 'not lonely', and this value (equivalent to 24 on the UCLA scale) was used as the threshold.

Thus individuals crossing the threshold will be those with a score greater than 24 by 1.62 points or less before the intervention. Given that the scale is discrete, i.e. individual scores can only be integers, the difference of 1.62 could be rounded up to 2. However, to be conservative, we have rounded down to 1. In other words, only individuals with a score of 1 above the threshold at baseline will cross the threshold.

From the interquartile range of baseline loneliness reported by White, we know that 25 is below the 25th percentile of scores. Given that most values are above 31 (the first quartile value), we can assume that more people score at 31 than at 20 (the end of the scale, i.e. least lonely people). However to be conservative, and in the absence of information on how individuals are distributed, we have assumed that the 25 percent of individuals scoring up to 31 are evenly distributed across each of the twelve values between 20 and 31.



The graph above shows that at baseline, we assume an equal distribution of the first quartile of individuals between the scores of 20 to 31. Our conservative assumption is that individuals will move down by an average

of 1 point, and thus after the intervention, one twelfth of individuals cross the threshold (25). This is equal to 2% of individuals, and so 2% is used in the model.

Running the model using these inputs and the non-intervention specific inputs shown above shows that the intervention leads to a reduction in all the diseases measured, as shown below:

Table 26: Intervention impact on health outcomes

Health Outcome	% reduction	Cost saving per person*	QALY gain per person
Depression	0.67%	£48	0.0138
Dementia	0.14%	£44	0.0005
Physical activity	1.24% increase	*Only impact on subsequent diseases measured*	
Diabetes	0.09%	£9	0.0016
Stroke	0.1%	£62	0.0005
CHD	0.17%	£61	0.0050

**Future values discounted*

Note that cost savings and QALY gains per person are the disease figures multiplied by the percentage reduction, i.e. per all persons in the intervention.

The overall results of the CUA are shown below:

Table 27: Internet and computer training results

Outcome	Value
Cost savings per person	£224
Net present value per person	-£340
Benefit:cost ratio	0.4
Total QALYs gained per person	0.021
ICER (Incremental Cost-Effectiveness Ratio)	£15,962

The results shown above indicate that the benefits in improving health outcomes due to reduced loneliness save £224 per person, compared to an intervention cost of £564 per person, which equates to savings of 40p per £1 spent, and a net cost of £340 per person. The intervention leads to an average gain of 0.021 QALYs per person, and thus a cost of £15,962 per QALY. This falls under NICE's implied cost-effectiveness threshold of £20,000, so looking only at the impact of the intervention on loneliness and the health outcomes above resulting from loneliness (i.e. leaving out all the other benefits discussed in the cost-consequence and potentially others not captured in the study) the intervention can be deemed cost-effective.

Sensitivity analysis

For those variables that were particularly key, particularly uncertain, or where we had to choose between a number of possibilities, we conducted sensitivity analysis: adjusting those variables and measuring the overall impact on results. These are summarised as follows:

- Sensitivity analysis 1 (SA1): We adjusted the cost of the intervention by 50% either side (£282 = Low; £846 = High)
- Sensitivity analysis 2 (SA2): We adjusted the effect on loneliness by 50% either side (0.01 = Low; 0.03 = High)
- Sensitivity analysis 3 (SA3): We assumed the cost of depression applied to everyone, rather than just those who typically access health services (i.e. £2,413 per person, rather than £1,485)
- Sensitivity analysis 4 (SA4): Rather than assuming a healthy individual has a utility of 1, we have assumed 0.84, based on the weighted average of utilities for people aged 65-74[106]

The results for each scenario are presented in the table below, in comparison to the base case results:

Table 28: Internet and computer training sensitivity analysis

Outcome	Base case	SA1 Low	SA1 High	SA2 Low	SA2 High	SA3	SA4
Cost savings per person	**£224**	£224	£224	£112	£447	£253	£224
Net present value per person	**-£340**	-£58	-£904	-£452	-£117	-£311	-£340
Benefit:cost ratio	**0.4**	0.8	0.2	0.2	0.8	0.4	0.4
Total QALYs gained per person	**0.021**	0.021	0.021	0.011	0.043	0.021	0.012
ICER (Incremental Cost-Effectiveness Ratio)	**£15,962**	£2,735	£42,415	£42,415	£2,735	£14,568	£27,406

Table 28 shows that the results are quite sensitive to all but SA3. Adjusting the cost of the intervention down by 50% reduces the ICER by just over 80%; and increasing it by 50% more than doubles the ICER. Similarly, the effect on loneliness also results in significant changes. In particular, SA1 High; SA2 Low and SA4 all push the ICER to above £20,000, i.e. the intervention would be deemed not cost-effective (depending on the threshold employed – with a £30,000 threshold SA4 would still be cost-effective). SA2 Low in particular carries a very high ICER, and this is because the intervention's effect on loneliness drives all the benefits in this CUA. In no scenario is a positive net present value achieved.

However, as mentioned before, the CUA only measures health outcomes resulting from a change in loneliness. Although the model is sensitive to the estimates of loneliness which were derived from the study paper and the Cotten paper in something of a complex manner, other benefits which we were unable to quantify in a CUA – but which are discussed in the CCA – could likely drive down the ICER significantly.

5.2.2 Friendship programmes

The following information was included in the model for this intervention:

Table 29: Friendship model parameters

Parameter	Value	Explanation & Source
Average of age of participants	63	Martina 2006[107]
Cost of the intervention per person	£77	Calculation from the CCA excluding follow up interviews and tokens (the alternative cost is explored in the sensitivity analysis)
Incremental effect of the intervention: reduction in loneliness	0.03	Described below

The incremental effect of the intervention was calculated assuming a normal distribution, based on the means and standard deviation reported by Martina (2006). The mean values for the intervention arm were 7.49 at baseline and 6.63 after the intervention, on the Gierveld & Tilburg scale where 0-2 is not lonely, 3-8 is moderately lonely and 9+ is severe (as described in the CCA). For the control arm the mean before was 4.96 and the mean after was 4.71. Standard deviations for the intervention arm were 3.52 before and 3.59 after; for the control arm they were 4.16 before and 3.93 after.

It is important to note that although the decrease in loneliness (from 7.49 to 6.63) over time in the intervention group was significant, and the decrease in loneliness over time in the control group (from 4.96 to 4.71) was not, the difference between these declines was not statistically significant. We have included the decrease in loneliness on the basis that the not significant control group decline can be discounted, and we would not assume loneliness to decline in a group with no intervention. However, we have subtracted this effect from the effect of the intervention over time, and recommend that these results be interpreted with caution.

By assuming a normal distribution of values (in the absence of further information suggesting a more appropriate distribution) we calculated the number of people 'not lonely' (i.e. scoring 0-2) for each arm, before and after. In the intervention arm, this increased by 4% after the study (from 5.9% to 10%); in the control arm, there was an increase of 1% (from 24% to 25%). Subtracting the control arm effect from the intervention arm effect, a 3% reduction in loneliness was used in the model.

Running the model using these inputs and the non-intervention specific inputs shown above shows that the intervention leads to a reduction in all the diseases measured, as shown below:

Table 30: Intervention impact on health outcomes

Health Outcome	% reduction	Cost saving per person*	QALY gain per person
Depression	1.04%	£74	0.021
Dementia	0.21%	£68	0.001
Physical activity	1.93% increase	*Only impact on subsequent diseases measured*	
Diabetes	0.13%	£24	0.004
Stroke	0.15%	£129	0.001
CHD	0.27%	£96	0.008

**Future values discounted*

Note that cost savings and QALY gains per person are the disease figures multiplied by the percentage reduction, i.e. per all persons in the intervention.

The overall results of the CUA are shown below:

Table 31: Internet and computer training results

Outcome	Value
Cost savings per person	£391
Net present value per person	£314
Benefit:cost ratio	5.1
Total QALYs gained per person	0.035
ICER (Incremental Cost-Effectiveness Ratio)	Dominant

The results shown above indicate that the benefits in reducing health outcomes due to reduced loneliness save £391 per person, compared to an intervention cost of £77 per person, which equates to savings of £5.10 per £1 spent, and a net *saving* of £314 per person. In other words, paying for the intervention saves money overall (although the savings accrue to the health service – not necessarily to the intervention funder).

The intervention leads to an average gain of 0.035 QALYs per person. An ICER cannot be calculated, as the intervention both saves money and gains QALYs – thus it is 'dominant' over its comparator (there is no trade-off between money and health). Thus even just looking at the impact of the intervention on loneliness and its effects on the health outcomes above, excluding all other potential benefits, the intervention is unambiguously cost-effective: it is both effective and cost-saving. (As mentioned in the cost-consequence analysis, this intervention was for women only, so these results only hold for a friendship programme targeted at women.)

Sensitivity analysis

As for the internet and computer training intervention above, we conducted sensitivity analysis on key and/or particularly uncertain variables. These are summarised as follows:

- Sensitivity analysis 1 (SA1): We adjusted the cost of the intervention by 50% either side (£38.50 = Low; £115.5 = High)
- Sensitivity analysis 1a (SA1a): We used the cost of the intervention that includes follow up interviews and tokens given to participants (£120) – these were left out in the base case costing as they are likely

not to be included in rollout of such a programme in a non-research setting, but this cost reflects the original study more accurately

- Sensitivity analysis 2 (SA2): We adjusted the effect on loneliness by 50% either side (0.015 = Low; 0.045 = High)
- Sensitivity analysis 3 (SA3): We assumed the cost of depression applied to everyone, rather than just those who typically access health services (i.e. £2,413 per person, rather than £1,485)
- Sensitivity analysis 4 (SA4): Rather than assuming a healthy individual has a utility of 1, we have assumed 0.84, based on the weighted average of utilities for people aged 65-74[106]

The results for each scenario are presented in the table below, in comparison to the base case results:

Table 32: Friendship programmes sensitivity analysis

Outcome	Base case	SA1 Low	SA1 High	SA1a	SA2 Low	SA2 High	SA3	SA4
Cost savings per person	**£391**	£391	£391	£391	£195	£781	£437	£391
Net present value per person	**£314**	£352	£237	£271	£118	£704	£360	£314
Benefit:cost ratio	**5.1**	10.1	2.5	3.3	2.5	10.1	5.7	5.1
Total QALYs gained per person	**0.035**	0.035	0.035	0.035	0.018	0.071	0.035	0.020
ICER (Incremental Cost-Effectiveness Ratio)	**Dominant**	Dominant in all						

Table 32 shows that for all scenarios, the intervention remained dominant, i.e. it saved money and provided positive health outcomes. This suggests that the conclusions from the base case analysis – that the intervention is cost-saving and effective – are relatively robust.

6.0 Local Authority level extrapolation

In order to provide further insight into the results of the cost-consequence analysis and the cost-utility analysis (presented below) from a Local Authority perspective, we have extrapolated results to a representative population size (where possible).

There are 152 Local Authorities across England,[108] covering 53.9 million people.[109] 17.4% of the UK population is aged 65 or over[109]. This gives an average of approximately 61,700 older people in each Local Authority (although this ranges from 138,000 in Birmingham to 6,000 in Corby, excluding the City of London (1,000))[110]

Given that many of these individuals will have existing substantial health or social care needs and thus be beyond the scope of this guidance and/or will not be reached by every programme, we have extrapolated scalable per person figures to an example population size of 20,000, to provide information on Local Authority-level costs and some of the consequences. Note that this section extrapolates predominantly financial results: individual-level results measured on a scale (e.g. morale or wellbeing) are not included and as such it complements the cost-consequence and cost-utility analyses, rather than providing a standalone interpretation of results.

6.1 Arts based intervention: singing

Providing this intervention to 20,000 people in a given Local Authority (LA) would cost £1.72 million, assuming that a 90-person programme is directly scalable.

As with all of these interventions, individuals interested in the programme are more likely to participate, and it is also likely that some individuals would sign up for multiple, or consecutive, courses if they enjoyed the activity. The extent to which participating in multiple programmes would increase benefits (potentially less each time) has not been explored in this analysis. Similarly, we have also assumed for each intervention that individuals complete the programme (or continue for such a time as to receive the same benefits).

Assuming benefits can be scaled up, the individual savings of £2.40 per person equate to £48,000 in total, from one fewer over the counter medication per year.

The health system would save a total of £1.84 million as a result of 40,000 fewer GP visits per year.

Compared to individuals who don't participate, a total of 7,200 falls would be prevented, likely to prevent thousands of hip fractures and care home admissions, and (assuming 28% of older people die within 12 months of a fall) 2,016 deaths. (However, the number of deaths may be lower in reality given those who die following falls are likely to be more frail to begin with.)

6.2 Internet and computer training intervention

Providing this intervention to 20,000 eligible people in a LA would cost £11.28 million.

As before, benefits of participating in multiple programmes are not included (however, the original study is predominantly made up of those with some computer experience).

51% of participants with no prior experience started using the internet at least weekly in the original study, as did 80% of those with computer experience. In order to extrapolate, we assume the same mix of individuals

(69% with no previous experience vs. 31% with some) in extrapolating figures, as well as assuming results from a 2002 study remain accurate for 2015.

The cost-utility analysis suggests a 2% reduction in loneliness, i.e. 400 'lonely' people would become 'not lonely'. This would result in the following impacts:

Table 33: LA extrapolation of CUA results

Health Outcome	% reduction	No. people	Total cost saving	Total QALY gain
Depression	0.67%	134	£1,000,000	275
Dementia	0.14%	28	£880,000	10
Physical activity	1.24% increase	249	*Only impact on subsequent diseases measured*	
Diabetes	0.09%	17	£170,000	31
Stroke	0.1%	20	£1,200,000	11
CHD	0.17%	35	£1,120,000	99

**Future values discounted*

In other words, 134 people would avoid depression, 28 would see a delay in the onset of dementia, and 249 more people would become physically active, preventing 17 instances of diabetes, 20 of stroke and 35 of CHD. (Importantly, these figures cannot be summed as more than one benefit may well apply to the same individual.)

The total cost saving to the health service of this equates to £4.47 million, resulting in a net cost of £6.8 million, and the total QALY gain is 426. This excludes benefits in terms of reduced mortality, as well as other gains discussed in the cost-consequence analysis such as social network benefits.

6.3 School based intergenerational activities and volunteering

Extrapolating the cost of this intervention to 20,000 people results in a cost of £200,000. However, it is perhaps unrealistic that a school-based volunteering programme could be rolled out to quite this extent.

The value of volunteering, estimated at £81 per session, would be £1.62 million even if each individual only completed one session. The other benefits noted in the CCA, including social network benefits, do not contain figures that can be extrapolated to a population-level

6.4 Friendship programmes

Providing this intervention to 20,000 eligible people in a LA would cost £2.4 million.

Benefits of participating in multiple programmes are not included.

The cost-utility analysis suggests a 3% reduction in loneliness, i.e. 600 'lonely' people would become 'not lonely'. This would result in the following impacts:

Table 34: LA extrapolation of CUA results

Health Outcome	% reduction	No. people	Total cost saving	Total QALY gain
Depression	1.04%	208	£1,500,000	427
Dementia	0.2%	43	£1,400,000	16
Physical activity	1.93% increase	386	*Only impact on subsequent diseases measured*	
Diabetes	0.13%	27	£500,000	87
Stroke	0.15%	31	£2,600,000	22

CHD	0.27%	54	£1,900,000	155

**Future values discounted*

In other words, 208 people would avoid depression, 43 would see a delay in the onset of dementia, and 386 more people would become physically active, preventing 27 instances of diabetes, 31 of stroke and 54 of CHD. (Importantly, these figures cannot be summed as more than one benefit may well apply to the same individual.)

The total cost saving to the health service of this equates to £7.81 million, resulting in a net *saving* of £6.27 million, and the total QALY gain is 706. This excludes benefits in terms of reduced mortality, as well as other gains discussed in the cost-consequence analysis such as life satisfaction, self-esteem and social network benefits.

7.0 Conclusions

The literature review we conducted (described above) indicated that the evidence on the impact of independence and mental wellbeing on health and other outcomes was fairly disparate and weak. Partly this is due to the lack of studies framing questions in this way – many measure independence and mental wellbeing as outcomes in their own right. It is also due to the many measurement scales used, and the complex and interrelated relationships between these outcomes, making cause and effect difficult to establish (and most likely not linear). However, the results did suggest that an improvement in independence and mental wellbeing is associated with many other benefits, in terms of physical health, social relationships and mental health and mortality.

For this reason, we carried out a cost-consequence analysis for a selected number of interventions, as it was felt statistical evidence was not strong enough to provide a cost-utility estimate. Results for the four studies examined – arts-based (singing), internet and computer training, school-based intergenerational activities and volunteering, and friendship programmes – are presented above.

There was, however, a substantial amount of evidence on the impact of loneliness picked up in our review and in grey literature searches. A systematic literature review targeted specifically at loneliness may pick up additional evidence. In order to provide some cost-effectiveness metrics, a 'sub-model' measuring costs and QALYs for those studies that reported a significant impact on loneliness (internet and computer training and friendship programmes) was conducted.

The cost-utility model only measured the impact of loneliness on specific health outcomes where good quality data was available: depression, dementia and physical activity; and through physical activity, diabetes, stroke and CHD (coronary heart disease).

All four interventions delivered positive benefits versus their comparators. The singing intervention (chorale singing participation) delivered both financial savings overall, in terms of fewer over the counter medications, fewer GP visits, and importantly, reduced falls. All of these outcomes suggest improved wellbeing and improved health outcomes – in the case of reducing falls (versus an increase in the comparator) this could be very significant. Although no statistically significant effect was found on loneliness, depression, total level of activity and 'other health problems', the intervention did also improve weekly activity and overall health and appeared to reduce a decline in morale and an increase in health service usage. However, it is difficult to interpret the extent to which many of the physical gains reported occur due to the social, or the physical aspects of a singing programme (and thus to what extent they are generalizable to other arts-based interventions). Other studies in this area have not found significant gains in the area of physical quality of life[2627]. Overall the intervention would be expected to deliver both cost savings, at a relatively small cost (£86 per participant) and improved health outcomes. A UK-based economic study on a similar singing programme is due to be published shortly[27].

The internet and computer training intervention was more expensive, at £564, and in the study paper did not deliver a statistically significant effect on loneliness or depression. However, it did lead to increased computer usage. Although not captured in the relatively short follow-up of the original paper, other evidence suggests that increased computer usage can lead to a variety of positive outcomes: a decrease in loneliness, making it easier to reach people and staying in touch, making it easier to meet new people, an increase the quantity of communication with others, a reduction in isolation, makes individuals feel more connected to friends and family and increases the quality of communication. This in turn is likely to lead to improved outcomes for such things as depression, physical health, and dementia and reduce mortality. It should be noted that the intervention paper is from 2002 – more up to date research in this area has been done but this paper was chosen as it best met the criteria for this economic analysis.

Given the outcomes for loneliness, this intervention was included in the cost-utility analysis. Focusing only on the health outcomes that are improved by a reduction in loneliness, internet and computer training resulted in a net cost of £340 per person and an improvement of 0.021 QALYs, giving an incremental cost-effectiveness ratio (ICER) of £15,962, which, at less than £20,000, suggests the intervention is cost-effective on these outcomes alone.

The school-based intergenerational activities and volunteering intervention also reported positive outcomes in terms of social intergenerational outcomes, self-rated health and providing social support. Received support from friends declined, however the authors drew attention to the potential impact of "pride … prevent[ing participants] from accepting social support" as a possible explanation. The improved social outcomes would be expected to lead to improved health and potentially mortality. The value of volunteering was quantified in the cost-consequence analysis, and far outweighed the small intervention cost (£10 per participant), suggesting a cost-effective intervention in those terms alone (although this assumed volunteers add to, rather than replace, paid work). This intervention was conducted in Japan, so caution may be needed in interpreting results to a UK context.

Finally, the friendship programmes, delivered at a cost of £77 per person, led to a variety of positive outcomes in terms of friendship (new friends, contact with friends, etc.), self-esteem, self-efficacy and life satisfaction. All of this is likely to improve physical and mental health and mortality. This study also reported significant improvements in loneliness, and so was included in the cost-utility analysis. It was found to be 'dominant' in cost-effective terms, meaning that even when only looking at health outcomes improved by a change in lonely, it both saved money (with a net saving of £314 per person) and improved health outcomes (by 0.035 QALYs per person).

Although the evidence presented in these economic analyses does require some subjective judgement, the cost-consequences presented above, coupled with cost-utility figures for one particular aspect of independence and wellbeing, suggest that many interventions such as these can be helpful in improving physical and mental outcomes for healthy older people, and are likely to be and beneficial and potentially cost-effective.

The limitations of this analysis include the case study approach, whereby only a small number of interventions were selected for in-depth analysis (given the scope of this study and the timelines available). However, the methodological approach used could be rolled out to include more programmes in future.

Results for each intervention only cover the follow-up period of each study (aside from in the cost-utility model). As such, any knock-on benefits (e.g. participating in more programmes, the 'halo' effect of volunteering etc.) were not captured; similarly, the question of how long benefits are sustained for was not answered. A difference can also be drawn between singing and volunteering, which are ongoing programmes, and internet training and friendship programmes, which were one-off. The extent to which this difference affects longer-term outcomes is not known.

Additionally, each intervention was compared to its comparator, which often was 'usual activity' or 'no programme' – in reality, a Local Authority will have to consider what else is available in the area; and the issue of achieving and sustaining uptake of programmes in the 'real world' was also not considered. This analysis has shown that several types of programmes can have positive effects – perhaps an immediate question for Local Authorities to consider is how to get older people to participate in one or more programmes, regardless of the specific nature of each programme.

As well as the above, areas where future research would be useful are: identifying people at risk and raising awareness, of which little was published in the studies we identified; linking together the myriad effects of improving independence and wellbeing, as well as what factors cause such an improvement (there may well be a 'virtuous cycle' of improvement) and understanding to what extent interventions can be tailored towards

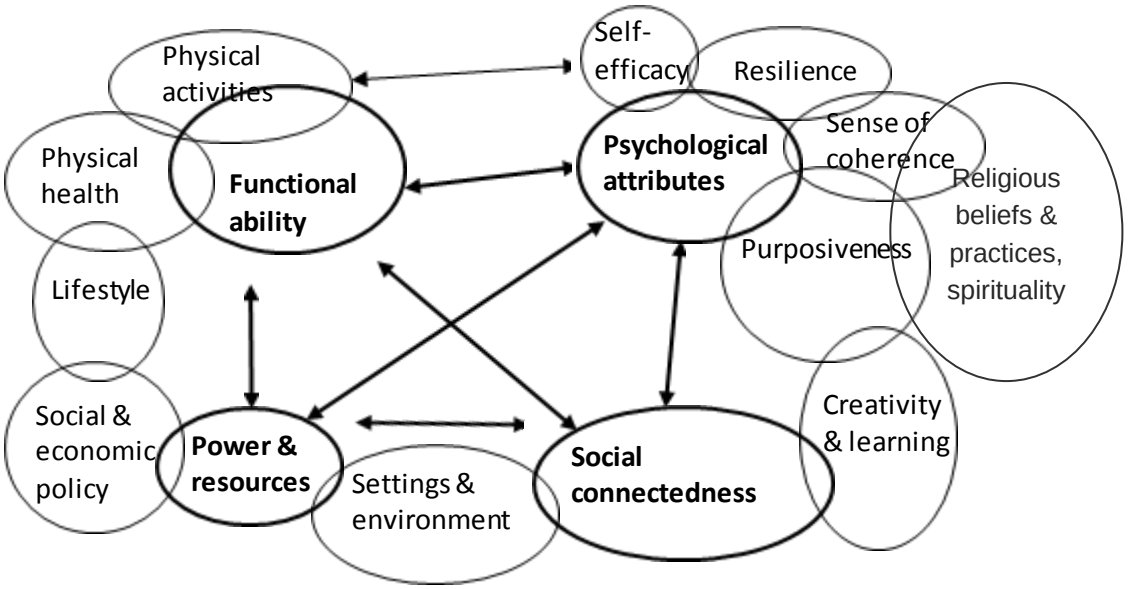
individuals in a given area, to ensure that all older people are included, rather than a potential bias where only those interested in a particular activity take part.

8.0 Appendix

8.1 Theoretical Framework

Prof Mima Cattan, Professor in Public Health at Northumbria University and member of the PHAC, has developed a draft theoretical framework of the foundations of mental wellbeing in later life. This comprises four interconnected pillars, supported by a variety of additional elements, as shown in the diagram below.

Figure 4: Foundations of mental wellbeing in later life, first draft[111]



We have categorised each of the interventions used in the CCA according to this framework, in order to provide information to the PHAC as to how the four programmes fit into a model of mental wellbeing. Where interventions were targeted at a specific area (and achieved benefits there), this is marked with a T. Where benefits were observed in areas beyond that which the intervention specifically targeted, these are marked with a B. There is some subjectivity around the extent to which outcomes measured in intervention papers fit into these headings, so where doubt remains this is marked with a question mark.

Table 35: Categorisation of CCA interventions according to the Cattan Framework

Intervention	Functional ability	Physical activities	Physical health	Lifestyle	Power & resources	Social & economic policy	Settings & environment	Social connectedness	Creativity & learning	Psychological attributes	Purposiveness	Religious beliefs & practices	Sense of coherence	Resilience	Self-efficacy
Arts based intervention: singing	B	B	B	B			T	T	T	B	B?		B?	B?	B?
Internet and ICT training	T	B	B	T	B		T	T	T	B	B?		B?	B?	B?
School based intergenerational	T		T	B		T?	T	T	T	B	T		B	B?	B

Friendship	B	B	B	B			T	T	T	B	B		B?	B?	B

8.2 CUA Calculations

Further detail on calculations for the CUA which were not described in full above are shown below:

Heikkinen: Incremental prevalence of depression given loneliness

One calculation for the incremental prevalence of depression given loneliness came from a paper by Heikinnen (2004)[6].

The odds ratio (OR) for depression for individuals 'seldom' lonely was given as 2.76 versus those 'never' lonely. The OR for depression for individuals 'often/always' lonely was 9.28. Using the 'seldom' lonely to represent 'not lonely' in our CUA, and 'often/always' to represent 'lonely', we calculated the relative risk (RR) of depression for lonely individuals as 9.28/2.76, which equals 3.36.

The numbers of individuals never or seldom lonely was 101, and the number of often/always lonely individuals was 36. Therefore 101/(101+36) = 0.737 represents the proportion of not lonely individuals. The paper also gave the overall prevalence of depression as 0.32.

From this, the prevalence rate of depression given 'not lonely' was calculated using the following formula:

*Prevalence of depression / (Proportion not lonely + (1 – Proportion not lonely) * RR of depression if lonely)*

Or:

*0.32 / (0.737 + (1 – 0.737) * 3.36)*

which equates to 0.2. Multiplying this figure by the RR of depression if lonely gives the prevalence of depression for lonely individuals, 0.66. Subtracting the latter by the former gives the incremental prevalence of depression for lonely individuals, 0.47.

Wilson: Incremental prevalence of dementia given loneliness

The calculation for the incremental prevalence of dementia given loneliness was calculated from Wilson and colleagues (2007)[7]. They provided a relative risk for Alzheimer's disease if not lonely of 0.52, the inverse of this: 1/0.52 = 1.92, represents the RR of dementia for lonely individuals.

Loneliness was assessed in the paper by a modified version of the de Jong-Gierveld Loneliness scale, with scores between 1 and 5. The mean score was 2.3, with a standard deviation of 0.6, where higher scores equate to greater loneliness. By assuming a normal distribution of scores and a threshold value of 2.5 (i.e. above this value participants are lonely), we calculated that 63.1% of participants were not lonely.

76 of 792 individuals in the study had Alzheimer's disease, giving an overall prevalence of 0.10. From these figures, the prevalence rate of dementia given 'not lonely' was calculated using the same formula as Heikkinen above.

0.10 / (0.631 + (1 – 0.631) * 1.92) = 0.07, representing the prevalence of dementia given not lonely. Multiplying this by the relative risk of dementia if lonely gives a prevalence rate for lonely people of 0.14. The difference between these figures, 0.07, represents the incremental prevalence of dementia for lonely individuals.

8.3 Search strategies

The search terms employed by John Eyers for the Medline database is given below. Search terms were slightly modified per database, and exact terms are available on request.

```
Database: Ovid MEDLINE(R) <1946 to September Week 1 2014>
Search Strategy:
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1      *aged/ or *"aged, 80 and over"/ (22397)
2      *Retirement/ (4763)
3      elder*.ti. (82596)
4      geriatric*.ti. (17097)
5      seniors.ti. (1539)
6      senior citizen*.ti. (397)
7      retire*.ti. (4837)
8      pensioner*.ti. (222)
9      "later life".ti. (1175)
10      "late life".ti. (1704)
11      "old age".ti. (6004)
12      (older adj people*).ti. (5675)
13      (old adj people*).ti. (990)
14      (older adj person*).ti. (2313)
15      (old adj person*).ti. (227)
16      (older adj adult*).ti. (15756)
17      ("older man" or (older adj men*)).ti. (1837)
18      ("older woman" or (older adj women*)).ti. (3123)
19      (older adj male*).ti. (168)
20      (older adj female*).ti. (120)
21      "old old".ti. (185)
22      "very old".ti. (827)
23      "oldest old".ti. (626)
24      (gray or grey or silver).ti. (20311)
25      (baby adj boom*).ti. (302)
26      or/1-25 (177226)
27      Independent Living/ (1155)
28      independence.ti,ab. (25807)
29      (independen* adj3 (live or living)).ti,ab. (3547)
30      "positive mental health".ti,ab. (219)
31      ((mental or social or emotional or psychological) adj3 ("well being"
or wellbeing)).ti,ab. (11692)
32      resilien*.ti,ab. (9856)
33      Resilience, Psychological/ (1650)
34      satisfaction.ti,ab. (72590)
35      Personal Satisfaction/ (11477)
36      empower*.ti,ab. (11936)
37      ((sense or locus or event* or future or circumstance* or situation*
or life) adj3 control).ti,ab. (14429)
38      Internal-External Control/ (16332)
39      Happiness/ (2759)
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40      (happy or happier or happiness).ti,ab. (8789)
41      Freedom/ (10108)
42      personal autonomy/ (16021)
43      ((personal or sense* or perception* or perceived or feeling* or
felt) adj5 (autonom* or vitality or meaning* or competen* or
freedom)).ti,ab. (7038)
44      or/27-43 (196731)
45      exp Health/ (266700)
46      health*.ti,ab. (1569480)
47      capab*.ti,ab. (235275)
48      (ability or abilities).ti,ab. (583114)
49      social isolation/ or social marginalization/ or Social Alienation/
(12490)
50      (isolat* or marginali* or exclu* or alienat*).ti,ab. (1290772)
51      Loneliness/ (2256)
52      lonel*.ti,ab. (3469)
53      Community Networks/ (5574)
54      ((community or social or family or civic) adj3 (relationship* or
participat* or isolat* or engag* or volunteer* or contact* or involv* or
inclu* or exclu*)).ti,ab. (68539)
55      ((mental or emotional) adj3 capital).ti,ab. (69)
56      Quality of Life/ or Health Status Indicators/ or Quality-Adjusted
Life Years/ (143906)
57      (quality of life or quality adjusted life or qaly* or qald* or qale*
or qtime*).ti,ab. (141090)
58      (disability adjusted life or daly).ti,ab. (1441)
59      (sf36 or sf 36 or short form 36 or shortform 36 or sf thirtysix or
sf thirty six or shortform thirtysix or shortform thirty six or short form
thirtysix or short form thirty six).ti,ab. (15670)
60      (sf6 or sf 6 or short form 6 or shortform 6 or sf six or sfsix or
shortform six or short form six).ti,ab. (999)
61      (sf12 or sf 12 or short form 12 or shortform 12 or sf twelve or
sftwelve or shortform twelve or short form twelve).ti,ab. (2689)
62      (sf16 or sf 16 or short form 16 or shortform 16 or sf sixteen or
sfsixteen or shortform sixteen or short form sixteen).ti,ab. (22)
63      (sf20 or sf 20 or short form 20 or shortform 20 or sf twenty or
sftwenty or shortform twenty or short form twenty).ti,ab. (335)
64      (euroqol or euro qol or eq5d or eq 5d).ti,ab. (3914)
65      or/45-64 (3699563)
66      26 and 44 and 65 (5770)
67      aged/ or "aged, 80 and over"/ (2392646)
68      Retirement/ (7754)
69      elder*.ti,ab. (172881)
70      geriatric*.ti,ab. (32311)
71      seniors.ti,ab. (4334)
72      senior citizen*.ti,ab. (1093)
73      retire*.ti,ab. (12859)
74      pensioner*.ti,ab. (780)
75      "later life".ti,ab. (6097)
76      "late life".ti,ab. (3904)
77      "old age".ti,ab. (18278)
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78      (older adj people*).ti,ab. (14389)
79      (old adj people*).ti,ab. (3143)
80      (older adj person*).ti,ab. (7554)
81      (old adj person*).ti,ab. (915)
82      (older adj adult*).ti,ab. (34220)
83      ("older man" or (older adj men*)).ti,ab. (6083)
84      ("older woman" or (older adj women*)).ti,ab. (10050)
85      (older adj male*).ti,ab. (1564)
86      (older adj female*).ti,ab. (1269)
87      "old old".ti,ab. (699)
88      "very old".ti,ab. (3006)
89      "oldest old".ti,ab. (1355)
90      (gray or grey or silver).ti,ab. (80239)
91      (baby adj boom*).ti,ab. (1204)
92      or/67-91 (2530887)
93      *Independent Living/ (532)
94      independence.ti. (4012)
95      (independen* adj3 (live or living)).ti. (443)
96      "positive mental health".ti. (45)
97      ((mental or social or emotional or psychological) adj3 ("well being"
or wellbeing)).ti. (1966)
98      resilien*.ti. (2874)
99      *Resilience, Psychological/ (1060)
100      satisfaction.ti. (15225)
101      *Personal Satisfaction/ (4650)
102      empower*.ti. (2952)
103      ((sense or locus or event* or future or circumstance* or situation*
or life) adj3 control).ti. (2694)
104      *Internal-External Control/ (5943)
105      *Happiness/ (1302)
106      (happy or happier or happiness).ti. (2262)
107      *Freedom/ (2746)
108      *personal autonomy/ (4705)
109      ((personal or sense* or perception* or perceived or feeling* or
felt) adj5 (autonom* or vitality or meaning* or competen* or freedom)).ti.
(1003)
110      or/93-109 (47102)
111      exp Health/ (266700)
112      health*.ti,ab. (1569480)
113      capab*.ti,ab. (235275)
114      (ability or abilities).ti,ab. (583114)
115      social isolation/ or social marginalization/ or Social Alienation/
(12490)
116      (isolat* or marginali* or exclu* or alienat*).ti,ab. (1290772)
117      Loneliness/ (2256)
118      lonel*.ti,ab. (3469)
119      Community Networks/ (5574)
120      ((community or social or family or civic) adj3 (relationship* or
participat* or isolat* or engag* or volunteer* or contact* or involv* or
inclu* or exclu*)).ti,ab. (68539)
121      ((mental or emotional) adj3 capital).ti,ab. (69)
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122     Quality of Life/ or Health Status Indicators/ or Quality-Adjusted
Life Years/ (143906)
123     (quality of life or quality adjusted life or qaly* or qald* or
qale* or qtime*).ti,ab. (141090)
124     (disability adjusted life or daly).ti,ab. (1441)
125     (sf36 or sf 36 or short form 36 or shortform 36 or sf thirtysix or
sf thirty six or shortform thirtysix or shortform thirty six or short form
thirtysix or short form thirty six).ti,ab. (15670)
126     (sf6 or sf 6 or short form 6 or shortform 6 or sf six or sfsix or
shortform six or short form six).ti,ab. (999)
127     (sf12 or sf 12 or short form 12 or shortform 12 or sf twelve or
sftwelve or shortform twelve or short form twelve).ti,ab. (2689)
128     (sf16 or sf 16 or short form 16 or shortform 16 or sf sixteen or
sfsixteen or shortform sixteen or short form sixteen).ti,ab. (22)
129     (sf20 or sf 20 or short form 20 or shortform 20 or sf twenty or
sftwenty or shortform twenty or short form twenty).ti,ab. (335)
130     (euroqol or euro qol or eq5d or eq 5d).ti,ab. (3914)
131     or/111-130 (3699563)
132     92 and 110 and 131 (5714)
133     aged/ or "aged, 80 and over"/ (2392646)
134     Retirement/ (7754)
135     elder*.ti,ab. (172881)
136     geriatric*.ti,ab. (32311)
137     seniors.ti,ab. (4334)
138     senior citizen*.ti,ab. (1093)
139     retire*.ti,ab. (12859)
140     pensioner*.ti,ab. (780)
141     "later life".ti,ab. (6097)
142     "late life".ti,ab. (3904)
143     "old age".ti,ab. (18278)
144     (older adj people*).ti,ab. (14389)
145     (old adj people*).ti,ab. (3143)
146     (older adj person*).ti,ab. (7554)
147     (old adj person*).ti,ab. (915)
148     (older adj adult*).ti,ab. (34220)
149     ("older man" or (older adj men*)).ti,ab. (6083)
150     ("older woman" or (older adj women*)).ti,ab. (10050)
151     (older adj male*).ti,ab. (1564)
152     (older adj female*).ti,ab. (1269)
153     "old old".ti,ab. (699)
154     "very old".ti,ab. (3006)
155     "oldest old".ti,ab. (1355)
156     (gray or grey or silver).ti,ab. (80239)
157     (baby adj boom*).ti,ab. (1204)
158     or/133-156 (2530364)
159     Independent Living/ (1155)
160     independence.ti,ab. (25807)
161     (independen* adj3 (live or living)).ti,ab. (3547)
162     "positive mental health".ti,ab. (219)
163     ((mental or social or emotional or psychological) adj3 ("well
being" or wellbeing)).ti,ab. (11692)
```

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164     resilien*.ti,ab. (9856)
165     Resilience, Psychological/ (1650)
166     satisfaction.ti,ab. (72590)
167     Personal Satisfaction/ (11477)
168     empower*.ti,ab. (11936)
169     ((sense or locus or event* or future or circumstance* or situation*
or life) adj3 control).ti,ab. (14429)
170     Internal-External Control/ (16332)
171     Happiness/ (2759)
172     (happy or happier or happiness).ti,ab. (8789)
173     Freedom/ (10108)
174     personal autonomy/ (16021)
175     ((personal or sense* or perception* or perceived or feeling* or
felt) adj5 (autonom* or vitality or meaning* or competen* or
freedom)).ti,ab. (7038)
176     or/159-175 (196731)
177     exp *Health/ (148199)
178     health*.ti. (484039)
179     capab*.ti. (7315)
180     (ability or abilities).ti. (26038)
181     *social isolation/ or *social marginalization/ or *Social
Alienation/ (4875)
182     (isolat* or marginali* or exclu* or alienat*).ti. (249867)
183     *Loneliness/ (1191)
184     lonel*.ti. (1210)
185     *Community Networks/ (3675)
186     ((community or social or family or civic) adj3 (relationship* or
participat* or isolat* or engag* or volunteer* or contact* or involv* or
inclu* or exclu*)).ti. (7750)
187     ((mental or emotional) adj3 capital).ti. (39)
188     *Quality of Life/ or *Health Status Indicators/ or *Quality-
Adjusted Life Years/ (63694)
189     (quality of life or quality adjusted life or qaly* or qald* or
qale* or qtime*).ti. (38543)
190     (disability adjusted life or daly).ti. (121)
191     (sf36 or sf 36 or short form 36 or shortform 36 or sf thirtysix or
sf thirty six or shortform thirtysix or shortform thirty six or short form
thirtysix or short form thirty six).ti. (972)
192     (sf6 or sf 6 or short form 6 or shortform 6 or sf six or sfsix or
shortform six or short form six).ti. (181)
193     (sf12 or sf 12 or short form 12 or shortform 12 or sf twelve or
sftwelve or shortform twelve or short form twelve).ti. (146)
194     (sf16 or sf 16 or short form 16 or shortform 16 or sf sixteen or
sfsixteen or shortform sixteen or short form sixteen).ti. (0)
195     (sf20 or sf 20 or short form 20 or shortform 20 or sf twenty or
sftwenty or shortform twenty or short form twenty).ti. (22)
196     (euroqol or euro qol or eq5d or eq 5d).ti. (586)
197     or/177-196 (905975)
198     158 and 176 and 197 (9584)
199     66 or 132 or 198 (15517)
200     limit 199 to (english language and yr="2003 -Current") (9648)
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201     limit 200 to (comment or editorial or letter or news) (36)
   202        200 not 201 (9612)
```

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