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Cost-effectiveness of a proportionate universal offer of free exercise: Leeds Let's Get Active

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ABSTRACT

Objectives: To assess the cost-effectiveness of a proportionate universal programme to reduce physical inactivity (Leeds Let's Get Active) in adults.

Methods: A continuous-time Markov chain model was developed to assess the cost implications and QALY gains associated with increases in physical activity levels across the adult population. A parametric survival analysis approach was applied to estimate the decay of intervention effect over time. Baseline model data were obtained from previous economic models, population-based surveys and other published literature. A cost-utility analysis was conducted from a health care sector perspective over the programme duration (39 months). Scenario and probabilistic sensitivity analyses were performed to test the robustness of cost-effectiveness results.

Results: 51,874 adult residents registered to the programme and provided baseline data, 19.5% of which were living in deprived areas. Under base case assumptions, Leeds Let's Get Active was found to be likely to be cost-effective. However, variations in key structural assumptions showed sensitivity of the results.

Conclusions: Results from this study suggest a non-negligible level of uncertainty regarding the effectiveness, and therefore, cost-effectiveness of a universal offer of free leisure centre-based exercise that targets hard to reach groups. Further data collection and a shift toward prospective evaluations are needed.

"WHAT ARE THE NEW FINDINGS?"

A proportionate universal offer of free off-peak exercise in public leisure centres can provide good value for money.

"HOW MIGHT IT IMPACT ON CLINIC PRACTICE IN THE NEAR FUTURE?"

Local governments should evaluate the possibility of providing proportionate universal access to off-peak exercise sessions in public leisure centres.

INTRODUCTION

Lack of regular physical activity (PA) is a major contributor to chronic disease and mortality in developed countries[1]. Physical inactivity increases the risk of many chronic conditions, determining 9% of all premature mortality worldwide[2], and impacting substantially on national health care budgets[3]. In the UK, physical inactivity accounts for £1 billion a year to the national health system, with estimates rising to around £7.4 billion when taking a societal perspective[4].

Cost-effectiveness analysis is used to inform decisions regarding which interventions should be commissioned[5]. Evidence on the cost-effectiveness of PA interventions has accumulated over the last two decades, though mostly on individual-level approaches[6]. While population-level interventions have been found to be cost-effective in the majority of cases, the number of these studies is currently limited, especially those assessing interventions aimed to reduce the number of physically inactive adults [7].

Leeds Let's Get Active (LLGA) was a city-wide programme developed by the Local Authority and funded in collaboration with Sport England and Public Health England, which was aimed to reduce physical inactivity levels in the local adult population. The LLGA offer consisted of provision of universal access to free off-peak City Council leisure centre-based exercise sessions to all city residents. In order to encourage residents from low socio-economic backgrounds to take up the offer, LLGA sessions were provided in 17 centres located in the most deprived areas of the city (i.e. proportionate universal offer). Exercise sessions included the use of free weight areas, swimming pool access and fitness classes. This form of LLGA ran for 39 months, from October 2013 to the end of December 2016. This paper reports the results of a cost-utility analysis to determine the cost-effectiveness of the LLGA programme.

METHODS

Physical activity

In the six months prior to the start, a marketing campaign (billboards, leaflets, radio ads) was launched to promote participation, which was also encouraged through word of mouth throughout the programme. Any resident could sign up either in person at the leisure centres or on-line (dedicated web site). At the moment of their registration, participants were asked to self-report their current level of PA (baseline). This was based on a single-item question derived from the short-form IPAQ questionnaire[8], which asked how many active days (defined as days with at least 30 minutes of at least moderate PA[9]) they had over the past week. A definition (i.e. activities that take moderate physical effort and make your breath a little harder than normal) and examples of what constitutes moderate PA (e.g. carrying light loads or bicycling at a regular pace) were provided to participants. Access to the free sessions was electronically monitored by means of a card which participants were required to swipe at the leisure centre gates. No restrictions were imposed in terms frequency of access to the free exercise sessions. Following registration, a convenience sample of participants were surveyed a second time, either in person at the leisure centre or on-line.

Measures of behaviour change

In the cost-effectiveness analysis, programme effectiveness was defined as the ability of LLGA to affect a change in PA category. Four PA categories were defined according to the current UK PA recommendations for adults[10]: inactive=zero, insufficiently active=1 or 2, moderately active=3 or 4, active=5 to 7 active days a week. Two measures of behaviour change were available. The first (hereinafter "survey measure") was based on the survey data only, as the change in self-reported PA category observed between baseline and post-registration. The second measure (hereinafter "card swipe measure") was calculated as the probability of participants to improve baseline PA category due to a weekly access to LLGA sessions. Card swipe data were also analysed to obtain LLGA attendance drop-off patterns (i.e. time period between first and last LLGA session attended or end of the programme), which were used as a proxy for decay of intervention effect over time.

Analysis approach

Residents aged 16 years old or over who registered to the programme and for whom basic baseline data (i.e. age, gender, IMD and PA level) were available were defined as participants. For base-case estimation of effectiveness, a complete case analysis approach was applied in line with a previous similar study[11]. An ordered logistic regression model was specified, with subsequent estimation of PA transition probabilities. Stata software version 14 was used for all regression analyses.

Intervention costs

Appendix I includes the financial audit reports provided by LLGA administrators which include the cost breakdown by project function/component. To align with the approach currently adopted to inform reimbursement decisions by the NHS[12], the budget expenditure was assumed to represent the opportunity cost of implementing the intervention, under a constrained budget at a current

£20,000 - £30,000 willingness-to-pay (WTP) threshold range[13]. The unit programme cost was therefore calculated by dividing the allocated budget by the number of programme participants.

Decision-analytic model

Building on previous decision-analytic models[11 14 15], a continuous-time state-transition Markov model was developed to estimate incremental costs and QALYs associated with implementing a LLGA programme, relative to a no-intervention alternative, in the adult general population. A schematic of the model is shown in Figure 1.

All participants start the model in the healthy state. This state is a nested Markov chain consisting of four PA states. The model allows for transition between the four PA states over time. An integrated parametric survival approach allows for time-dependent PA transition probabilities to be specified. In summary, the model simulates the progression of a cohort of participants from a healthy state to death or 100 years of age. At the end of each cycle, a participant can either remain healthy, move to any disease state or die. The probability of becoming ill changes based on the participant's PA level, which can be changed by the intervention. From a disease state, a participant can either remain in that same state or die.

Utility decrements were used to model utility losses due to a disease diagnosis. Seven chronic diseases and conditions were included[16]. Specifically, Type II Diabetes, Coronary heart disease, Stroke, Colorectal, Breast cancer, Depression and Frailty syndrome. In line with the available evidence, the probability of developing a Frailty syndrome starts at age 65. Time-independent risks of developing one of the diseases are conditional on index of multiple deprivation (IMD) status (deprived or non-deprived) and PA level, which were assumed independent factors. In order to capture variations in utility due to changes in PA category before a diagnosis of disease, utility values were attached to each PA/IMD state. Once within a particular a disease state, a participant faced an increased probability of dying from all-causes. Thus, the 12 states represented constitute the four PA categories, the seven diseases and death.

Model parameters

Model parameters were sourced from previous economic models, published literature and national statistics, giving priority to UK-based evidence. Utility values, unit costs for treatment and management of the seven diseases, deprivation and PA gradients of morbidity and disease-related risks of all-cause mortality (i.e. relative risks) were searched using Medline database. In line with a published study[15], where published evidence describing all the differential risks was not available, a linear interpolation method was employed. Table 1 reports the model baseline parameters and distributions.

National life tables were used to inform time-dependent background mortality risks from all causes. Utility data for the PA states were obtained from analysis of the Health Survey for England 2014 data. Following the approach used in a relevant published study[17], multivariate regressions were performed to estimate utility values as a function of IMD status and PA level.

The baseline PA category / number of active days was assumed to represent participants' PA habit before exposure to LLGA offer, which was assumed to remain constant over time (i.e. parallel trend assumption). The baseline age and proportions of PA habits in each of the two IMD deprivation groups corresponded to that of programme participants.

Economic evaluation

The decision problem was evaluated from a health care sector perspective, aligning the methods with previous economic evaluations[11 14]. A cost-utility analysis was conducted considering a programme duration time horizon to reflect a time that funders would find useful. Discount rate was set at an annual 1.5% for costs and outcomes. To facilitate the interpretation of cost-effectiveness results, the incremental net monetary benefit was calculated by multiplying the difference in QALYs between the two intervention options by £20,000, minus the costs associated with no-intervention[18]. The price year was 2016.

Sensitivity analysis

Scenario and probabilistic sensitivity analyses were performed to characterise the uncertainty surrounding the decision. First, an alternative lifetime time horizon was considered. Second, the measure of effectiveness was varied by using the card swipe data collected which implied that LLGA participants could only improve PA category by actively attending its free sessions. Third, a last-observation-carried-forward approach was applied to the survey measure. Therefore, zero change in PA level was assumed for participants for whom no follow-up outcome measurement was available. Finally, the assumption regarding the sustainability of the intervention over time was tested by assuming a no decay and a gradual return to baseline PA level (using the LLGA session drop-off pattern as a proxy). A Monte Carlo simulation was used to propagate the uncertainty through the model and allow model parameters to vary simultaneously[18].

RESULTS

51,874 adult residents registered to the LLGA programme and provided basic baseline data. Participants were aged 39 years old on average, and the majority were female (62.4%) and living in non-deprived areas of the city (80.5%). A total of 191,605 LLGA sessions were accessed by 23,481 participants over the 39 months of programme.

Table 2 below reports the frequency distribution of PA categories observed at baseline and post-registration by IMD status. For 547 participants, full survey outcome data were available for the base-case analysis. Of these, 50.5% increased their baseline PA category, 36.9% did not change it, while 12.4% reported a lower PA level. Around 45% of participants attended at least one LLGA session (n=23,481), 20,967 of which did so within the first 6 months since registration. Of these, fifty percent (n=11,814) attended up to 4 LLGA sessions, while only 529 improved their baseline PA category through a weekly participation to the free sessions. Figure 2 shows the distribution of participants by number of LLGA sessions attended throughout the programme. Participants from IMD deprived areas started at an overall lower PA level at baseline than the non-deprived group. Post-registration distributions of PA categories were found to be comparable between the two subgroups, indicating an only marginal difference in terms of intervention effect.

Cost-effectiveness

Population-level costs, QALYs and incremental (deterministic) results are presented for the LLGA programme versus no scheme (see Table 3). Under base-case assumptions, LLGA shows to be the optimal strategy with an ICER of £555, well below the lower bound of the current WTP in the UK (£20,000) and providing an average positive INMB of £174 per participant. When varying the time horizon to a lifetime, LLGA becomes the dominant strategy, with negative incremental costs and QALY gains, and a per-participant INMB of £802. Comparable results are found when assuming no decay of intervention effectiveness over time and a gradual return to baseline PA level, with INMBs at £896 and at £619, respectively. Conversely, if effectiveness parameters are based on the card swipe measure or if zero change in PA category is assigned to participants not providing a follow-up survey measurement (last observation carried forward), LLGA is shown not to be cost-effective.

Figure 3 shows one thousand model iterations of the cost and QALY joint density plotted on a cost-effectiveness plane, comparing LLGA intervention to a no-intervention scenario, <under base-case assumptions. Looking at the distribution of cost and QALY pairs, the majority fall below the WTP

lower bound, indicating that there is a high probability of LLGA being the optimal alternative. Figure 4 shows the probability of LLGA being cost-effective, across a range of WTP thresholds. The cost-effectiveness acceptability curve (CEAC) did not cut the y-axis at zero (i.e. 55%) indicating that part of the joint density involved cost-savings[19]. Reflecting what was displayed in Figure 3, there is a high probability (95%) of LLGA being the optimal strategy was found when considering a £20,000 threshold.

DISCUSSION

Main findings

Results from this cost-utility analysis indicate that LLGA is highly likely to be cost-effective under base-case assumptions. The net benefits of implementing LLGA increase as a longer time horizon is considered. Scenario analyses also show that identification of the optimal strategy is highly dependent on variations to key structural elements regarding the sustainability of the intervention effect over time and assumed mechanisms of survey non-response.

What is already known on this topic

This study can be placed within the currently limited economic evaluation literature on population-level promotion of PA. In particular, the economic evaluation conducted to assess the cost-effectiveness of the BeActive programme[11]. This represents the main comparison study. LLGA mirrored the BeActive intervention modality, except that LLGA was offered only in City Council leisure centres located in the most deprived areas of the city. This afforded an opportunity to test the cost-effectiveness of providing universal access to free off-peak leisure centre-based sessions in another similar setting. For BeActive, base-case cost-effectiveness estimates were not dissimilar from those reported here, with an estimated £400 incremental cost per QALY gained. This finding supports the hypothesis that this type of population-level intervention represents good value for money also in the short term, and even when the offer is proportionate to attract hard to reach groups.

By contrast, BeActive appeared to be cost-effective even under the most conservative assumptions, though no further details were reported. Another comparable study simulated the implementation of a primary care-based universal intervention and found a 64.7% probability of the intervention being cost-effectiveness at a WTP threshold of £30,000.[14] One possible explanation for this difference in results is that, in that study, utility gains were accumulated only as a function of reduction in disease incidence and no utility gains were assigned from transitions to higher PA levels. Nevertheless, although some of the economic evaluation methods used in the present analysis were aligned with those studies (e.g. perspective, short time horizon), differences in the structures and parameters of the economic models limited the ability to directly compare our findings.

What this study adds

To the best of our knowledge, this represents the first cost-utility analysis of a proportionate universal programme to promote free off-peak leisure centre-based exercise in the general population. The programme is relatively easy to incorporate into currently operating public leisure centres (off-peak sessions), and therefore this intervention has the potential to be replicated in other comparable settings (i.e. local City Councils in the UK). As a result, this makes the evidence generated by this analysis particularly important for decision-makers that may be interested in evaluating the impact of implementing this type of intervention in the future.

Limitations of this study

The study is however subject to a number of limitations. In particular were the lack of experimental design, a non-research led data collection and handling process and restrictions imposed in terms of further data collection on residents/participants. This meant making the validity of effectiveness results depend on the plausibility of a parallel trend assumption, representativeness of the sample of participants providing full outcome data, as well as on untested measures of PA behaviour change which in turn relied on self-report. Furthermore, in absence of data on how the intervention costs were distributed, they were assumed as fixed. This should be considered when interpreting the results.

Although card swipe data were used to test the validity of the survey measure, the validity of the card swipe measure itself was based on a small subset of the total number of participants and relied upon the assumption that participants actively attended the exercise sessions. Moreover, while a sub-group analysis was conducted to account for heterogeneous effects, one of the objectives of public health is to reduce existing health inequality, which, due to resource constraints, was not possible to ascertain within this study.

Application of the QALY as the consequence considered in the evaluation restricted the evaluative space accordingly, therefore excluding non-health effects potentially generated by the intervention (e.g. increased work-related productivity[20]). However, in line with previous models[11 15 21], the decision-analytic model used for economic evaluation of LLGA was designed to accumulate utility gains/losses as a result of changes in PA state.

Although the decision-analytic model used for this economic evaluation allows for “natural” transitions between PA states to be captured, due to lack of relevant data, PA states were assumed to be stable over time in absence of the intervention. However, this may not always be necessarily the case, especially in the short term [22] and during sensitive life phases (e.g. retirement [23]). Further, the impact of an intervention like LLGA is likely to vary not only between individuals and over time, but also on whose economic perspective is taken. In this and previous studies [11 14], costs and benefits (QALYs) falling on the health care sector only were considered.

CONCLUSIONS

The results presented here contribute new information regarding the value for money of universal programmes to reduce physical inactivity in the general population. A number of strong limitations have been noted which do not allow for clear conclusions to be drawn regarding the cost effectiveness of LLGA. Many of the limitations relate to the paucity of data to inform the analysis rather than the methodology used.

The intrinsic complexity of the PA behaviour – health processes subject of evaluation represents a challenge for analysts, which is not exclusive to PA. However, retrospective involvements of research professionals add further complexity to the task and result in additional uncertainty due to methodological simplifications and choices that can have wide implications for decision-making. This could be addressed by shifting toward prospective evaluation models. An early involvement of the research team would be a useful support throughout all programme stages. While requiring more resources, this would help mitigate some of the issues relating, for example, to privacy concerns and data handling, which limit the potential for valuable research outputs, as well as to support the building of local research and implementation capacity.

COMPETING INTERESTS

There are no competing interests for any author.

CONTRIBUTORSHIP

PC was responsible for designing the study, data analysis, development of the economic model and drafting the manuscript. DM, AJH and LB contributed to the writing of the manuscript. All authors read and approved the final version of the manuscript.

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ETHICAL APPROVAL

Not applicable.

DATA SHARING STATEMENT

No data are available. Programme data have been provided by the local City Council under a Data Processing Agreement.

PATIENT INVOLVEMENT

There was no direct involvement of patients or the public in this work.

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Figure 1: Schematic of the Markov model

Figure 2: Distribution of LLGA participants by number of sessions attended

Figure 3: Cost-effectiveness plane

Figure 4: Cost-effectiveness acceptability curve