York Health Economics Consortium

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BRITISH CHIROPRACTIC ASSOCIATION

The Impact of Chiropractors on Workplace Productivity in NHS MSK Pathways

Final Report

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Abbreviations

AHP	Allied health professional
ASA	Advertising Standards Authority
BCA	British Chiropractic Association
DSA	Deterministic sensitivity analysis
GCC	General Chiropractic Council
HSE	Health and Safety Executive
LFS	Labour Force Survey
MSK	Musculoskeletal
NHS	National Health Service
ONS	Office for National Statistics
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
QOL	Quality of life
SMT	Spinal manipulative therapy
YHEC	York Health Economics Consortium

1 Introduction

1.1 Background

In 2017, the UK Government estimated that ill health among working-age people costs the economy £100 billion, with sickness absence costing employers £9 billion a year [1]. Poor health has the effect of shrinking the labour market and holding back economic growth. There are 3.8 million working-age people in employment with a work-limiting condition. It is predicted that the number of people aged between 20 and 69 living with major illness will rise by 600,000 by 2030.

The Health and Safety Executive has estimated that musculoskeletal (MSK) conditions accounted for 27% of all work-related ill health cases in 2022/23 [2]. More than 30 million working days are lost each year due to MSK conditions [3].

The British Chiropractic Association (BCA) is seeking to develop an argument that the chiropractic sector should form part of the strategic response to workforce productivity problems caused by MSK conditions. MSK conditions include a wide range of issues affecting muscles, bones, and joints, such as back pain, arthritis, and repetitive strain injuries.

Faster access to multimodal care (such as care delivered by manual therapists including, but not limited to, chiropractors, physiotherapists, and osteopaths) for some MSK conditions can reduce the number of sick days taken and ongoing treatment for condition management can support people to remain in work. When workers are unable to access treatment, this can result in longer periods of time out of work and the need for more complex and expensive treatment needs.

Chiropractors are not currently classified as allied health professionals (AHPs) in the UK. As a result, chiropractic provision is not included in the MSK strategy adopted by the NHS to address the waiting lists for MSK treatment.

The BCA commissioned York Health Economics Consortium (YHEC) to develop an analysis of the potential economic productivity benefits of integrating chiropractors into the wider MSK crisis strategy in the UK. This technical report sets out the analysis approach used, results of the analysis including various scenarios and the conclusions drawn from the analysis.

1.2 Objectives

The objective of this analysis was to establish how chiropractors could help to address the unmet need of people with MSK conditions, who are currently absent from work due to these conditions, on NHS MSK physiotherapy waiting lists. To help evaluate this, we aimed to answer the following questions:

- What sub-conditions of MSK are treated with equivalent or better effectiveness, regarding return-to-work outcomes, by chiropractors compared with physiotherapists and/or osteopaths?
- What is the unmet need of MSK treatment, by sub-condition, in the UK workforce?
- What chiropractic capacity is currently available?
- What are the potential economic gains, in terms of productivity, through improvements in peoples' ability to return to and remain in work through appropriate management or treatment of their MSK conditions?

2 Methods

2.1 Literature Review

To assess the available evidence on the relative effectiveness of chiropractors, physiotherapists and osteopaths a pragmatic literature review was undertaken. This consisted of a rapid, pragmatic search of existing literature evidence to explore the effectiveness of chiropractic interventions (in terms of productivity/return to work) compared with physiotherapists and/or osteopaths.

2.1.1 Eligibility criteria

The key elements of the analysis approach that informed the literature search strategy are set out in Table 2.1 in the form of a PICOT (population, intervention, comparator, outcomes, time horizon). This PICOT formed the eligibility criteria.

Table 2.1: Analysis approach

Analysis element	Description
Population	People in the UK workforce, currently absent due to an MSK condition and on the NHS physiotherapy waiting list. Specific MSK conditions focused on are: ▪ Back pain – not arising from injury. ▪ Osteoarthritis – must be use adjunct to core osteoarthritis treatments and exercise. ▪ Mechanical neck pain. ▪ Shoulder pain (excluding frozen shoulder). ▪ Knee pain.
Intervention	Chiropractors as part of the NHS MSK pathway, as an alternative to treatment by physiotherapists and osteopaths.
Comparator	Standard of care – treatment by physiotherapists and osteopaths only.
Outcomes	Time to return to work. Change in workforce productivity.
Time horizon	One year.

The population focused on conditions of high prevalence in the UK population that are causative of work absence. A list of potential conditions was sent to the BCA to adjust and align with professional experience. Conditions that had been selected were then checked against a list of conditions produced by the Advertising Standards Authority (ASA) who has produced a list of medical conditions that chiropractors can claim to treat [4]. The list of MSK conditions is intentionally restricted and is not intended to comprehensively cover all MSK conditions that chiropractors can treat.

2.1.2 Search strategies

The search strategies that were produced reflected the pragmatic review context. The strategies were not designed to be ‘comprehensive’ but focused to target records for relevant studies whilst retrieving record numbers that were manageable within the project timescales and available resources. The search strategy used for the MEDLINE (OvidSP) database can be found in Appendix A.

The strategy comprised of three concepts:

- MSK conditions (search lines 1 to 60).
- Single and multimodal chiropractic interventions (search lines 61 to 78).
- Productivity/return to work (search lines 79 to 98).

The concepts were combined as follows: MSK conditions AND chiropractic interventions AND productivity/return to work.

The strategy was devised using a combination of subject indexing terms and free text search terms in the Title, Abstract, and Keyword Heading Word fields. The search terms were identified through discussion with the BCA and within the research team, scanning background literature and browsing database thesauri.

The search terms for the population concept were the focused conditions of high prevalence in the UK population that are causative of work absence, outlined in the eligibility criteria. The conditions were intentionally restricted to the main terms for the conditions of interest.

The search terms for the intervention concept included terms for chiropractors, chiropractic, and a selection of the interventions that could be delivered by chiropractors. The choice of search terms was not intended to comprehensively cover all interventions that could be delivered by chiropractors. It was intentionally restricted to the main terms for the most common interventions.

The strategy was designed to retrieve studies where the database record explicitly referred to return-to-work/productivity outcomes. Although this approach has inherent potential limitations (outcomes are not always well described in the title or abstract of papers and are not always well indexed with controlled vocabulary terms applied to databased records), it was appropriate for the pragmatic review context (where searches should aim for high sensitivity but balance this thoroughness with the efficacy required by project resources [5]).

To work within the timeframe and resource available, it was decided that the search would be limited to two databases, alongside grey literature.

Pragmatic search methods such as these increase the risk of not retrieving some relevant studies, and adverse perceptions of methodology and processes, but they decrease the number of records retrieved for screening and further assessment and can therefore be appropriate for rapid literature review.

The strategy excluded animal studies from MEDLINE using a standard algorithm (search line 100). The strategy also excluded some ineligible publication types that were unlikely to yield relevant study reports (editorials, news items, and case reports) and records with the phrase ‘case report’ in the title (search line 101).

The strategy was restricted to studies published in English language (search line 104).

The final Ovid MEDLINE strategy was peer-reviewed before execution by a second Information Specialist. Peer review considered the appropriateness of the strategy for the review scope and eligibility criteria, inclusion of key search terms, errors in spelling, syntax and line combinations, and application of exclusions.

We searched for peer-reviewed literature in the following databases:

- MEDLINE (Ovid).
- Cumulative Index to Nursing and Allied Health Literature (CINAHL) (EBSCO).

To enhance the potential for identifying important records and grey literature, we also conducted searches of key websites to retrieve papers and reports that are not usually indexed in academic databases. We also considered literature shared by the BCA and their expert advisers for inclusion. The selection of resources reflected the pragmatic, rapid review context.

The structured search strategy for Ovid MEDLINE in Appendix A was translated into CINAHL appropriately. Translation included consideration of differences in database interfaces and functionality, in addition to variation in indexing languages and thesauri. The final translated strategy was peer-reviewed by a second Information Specialist. Peer review considered the appropriateness of the translation for the database being searched, errors in syntax and line combinations, and application of exclusions.

2.1.3 Record processing and selection

Search results were downloaded to an EndNote Library, where they were de-duplicated. Records were single-screened due to time and resource constraints. During the screening process, search results were assessed according to their relevance to the eligibility criteria. The title, abstracts, or summaries were reviewed as appropriate to develop a suitable list of relevant documents. A record was kept of the search outputs and the initial assessment of eligibility for inclusion in the data extraction stage. The final shortlist of documents was discussed by the project team to agree those most suitable for data extraction. Electronic or paper copies of potentially relevant full papers meeting the eligibility criteria were obtained using local access routes and the University of York subscription services.

The number of studies identified by the search and excluded at various stages was recorded and reported in a Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) study flow diagram which can be found in Appendix B.

2.1.4 Data extraction

Data extraction was high level and limited to the key data of relevance to answer the questions set out in Section 1.2.

A data extraction sheet was developed in Excel. Key data for each relevant study was extracted into a searchable Excel template. The data extracted was in narrative format. The following elements were extracted from eligible studies:

- Bibliographic details: (authors, title, journal, and year of publication).
- Study design.
- Study objective.
- Description of the intervention, including the targeted group.
- Types of evaluation/study designs and methods used.
- Outcomes measured and the metrics used to measure them (work-related outcomes only).
- Summary of the results.
- Study limitations.

2.2 Database Scoping

A series of publicly available databases were scoped for potentially useful information to extract for the economic analysis. The final inputs used for the analysis and their sources are laid out in Section 2.3.2. The main datasets used came from the Office for National Statistics (ONS), NHS England, and the Health and Safety Executive.

2.3 Economic Analysis

2.3.1 Analysis approach

The analysis aimed to estimate the expected costs and benefits of using chiropractors to address the current MSK physiotherapy waiting list in the NHS, in the context of workforce productivity, compared with no chiropractic intervention availability. The specific outcomes of interest were:

- Number of days to return to work.
- Change in workforce productivity, calculated using average wages.
- Breakdowns by work sector.
- Chiropractic capacity to provide additional support to the NHS.

Whilst initially intended, it was not possible to calculate a breakdown of results by MSK condition, due to a lack of available data.

The economic analysis was conducted in Excel.

An analysis was conducted to quantify the economic value of a proportion of the people waiting for physiotherapy treatment for an MSK condition being treated by a chiropractor and returning to work more quickly. Initially, a simple method was employed, using population numbers and estimates of average waiting times to calculate the lost productivity of those on the waiting list. However, this analysis did not account for some important additional factors.

To supplement this, a simple Markov model was developed to incorporate a greater range of possible outcomes into the analysis. A Markov model is an analytical framework which uses disease states to represent all possible consequences of an intervention of interest [6]. These are mutually exclusive and exhaustive and, as such, each individual represented in the model can be in one and only one of these disease states at any given time. Individuals move ('transition') between disease states as their condition changes over time. Time itself is considered as discrete time periods called 'cycles' (typically a certain number of weeks or months), and movements from one disease state to another (in the subsequent time period) are represented as 'transition probabilities'. Time spent in each disease state for a single model cycle (and transitions between states) is associated with a cost and a health outcome. Costs and health outcomes are aggregated for a modelled cohort of people over successive cycles to provide a summary of the cohort experience, which can be compared with the aggregate experience of a similar cohort, for example one receiving a different (comparator) intervention for the same condition.

For this Markov model the disease states used were on the waiting list, chiropractic treatment, natural drop-off, recovered, or other treatment. The results of the Markov model were compared with the results from the initial analysis to see how similar the results were. The intention of this was to provide a more robust analysis compared with the initial simple method.

2.3.2 Inputs

This section outlines the inputs used for the analysis and how they were used in the calculations. It also lists the alternative inputs that were used in scenario analyses.

2.3.2.1 Population

In the base case, the population on MSK physiotherapy waiting lists was calculated by stratifying the UK population by age group, using ONS data [7], and applying age-stratified prevalence of MSK conditions published by Versus Arthritis [8] to estimate the population with an MSK condition. Due to data limitations the working age population was assumed to include only those aged between 20-65.

The employment rate of people of working age with an MSK issue was taken from a report from Versus Arthritis (originally from Arthritis Research UK) and was applied to the population [9]. The proportion of people who take sick leave due to their MSK condition was taken from a report by Loughborough University which was used to calculate the total number of people in the UK who were on sick leave annually due to an MSK condition [10]. The value in that report is specific to construction workers but has been applied to the whole cohort in the absence of a more appropriate input.

The population inputs are outlined in
Table 2.2.

Table 2.2: Population inputs

Age group	UK population [7]	MSK prevalence [8]	Calculated MSK population
Under 20	15,659,683	5%	782,984
20 to 34	13,225,487	17%	2,248,333
35 to 44	9,082,819	28%	2,543,189
45 to 54	8,566,819	40%	3,426,448
55 to 64	8,806,934	51%	4,491,536
65 to 74	6,610,168	60%	3,966,101
75 to 84	4,606,627	63%	2,902,175
85 and over	1,707,371	60%	1,024,423
Total population	**68,265,209**		**21,385,189**
Total working age population	**39,681,360**		**12,709,506**
Employment rate of working-age population with an MSK condition [9]	**59.4%**		
Proportion of working population with an MSK condition who are on sick leave due to their condition [10]	**21%**		
Total number of people off work on sick leave due to an MSK condition	**1,585,384**		

MSK – musculoskeletal.

The population was stratified by industry. This was done using data from the Labour Force Survey (LFS) provided by the ONS and published by the Health and Safety Executive (HSE) [11]. Estimated prevalence was used to generate the proportion of sick leave attributed to each industry. Estimates of the numbers of people on sick leave in each industry are provided in Table 2.3. Data were not reported for industry sectors A, B, D, E, J, L, T, and U due to small sample numbers. Therefore, the difference between 'all' sectors and the sum of those reported was divided between these industry sectors, weighted accordingly to the size of the industry workforce as reported in the ONS summary of labour market statistics dataset (March 2024 figures) [12]. These were calculated into proportions to apply to the total number of people off work on sick leave due to an MSK condition.

Industries T and U were grouped to match the way that median wages by industry are reported by the ONS.

The reason that the estimated prevalence was not used directly was that the LFS only reported MSK conditions caused by or made worse by work. This is likely to underestimate the true number of people off work due to their MSK condition.

Table 2.3: Sick leave population by industry

Industry	Estimated annual sick leave prevalence	Proportions	MSK sick leave population
A Agriculture, forestry and fishing	2,450	0.7%	10,672
B Mining and quarrying	312	0.1%	1,357
C Manufacturing	37,000	10.2%	161,152
D Energy production and supply	739	0.2%	3,220
E Water supply, sewerage and waste	1,644	0.5%	7,159
F Construction	37,000	10.2%	161,152
G Wholesale, retail and repair of motor vehicles	44,000	12.1%	191,640
H Transport and storage	20,000	5.5%	87,109
I Accommodation and food services	13,000	3.6%	56,621
J Information and communication	10,125	2.8%	44,100
K Finance and insurance	8,000	2.2%	34,844
L Real estate	4,296	1.2%	18,710
M Professional, scientific and technical activities	19,000	5.2%	82,754
N Administrative and support services	27,000	7.4%	117,597
O Public administration and defence; social security	24,000	6.6%	104,531
P Education	33,000	9.1%	143,730
Q Human health and social work activities	61,000	16.8%	265,682
R Arts, entertainment and recreation	7,000	1.9%	30,488
S Other services	14,000	3.8%	60,976
T, **U** Household and extraterritorial	434	0.1%	1,890
Total*	**364,000**	**100.0%**	**1,585,384**

MSK – musculoskeletal.
*Note: totals may not match exactly due to rounding.

Due to data limitations, it was assumed that the total population on sick leave due to their MSK condition is equal to the population on the MSK physiotherapy waiting list. Assuming that chiropractors would only be able to treat people on the waiting list for conditions that the ASA allows chiropractors to claim to treat [4], it was estimated that chiropractors could treat 50% of this waiting list. This estimate was calculated using Table 2 from Murtagh et al 2024, which provides descriptive statistics for diagnosis for physiotherapy cohort. The list of included diagnoses and the associated proportions are detailed in

Table 2.4.

Table 2.4: Conditions eligible to be treated by chiropractors

Condition	Proportion of population
Joint dysfunction/pain	18.6%
Muscular tenderness/dysfunction	8.9%
Non-specific low back pain (acute and chronic)	7.7%
Osteoarthritis	4.4%
Disc lesion with neural impingement	3.7%
Nerve impingement	2.7%
Rotator cuff	2.2%
Impingement syndrome	1.8%
Total	**50.0%**

2.3.2.2 Wages

Median weekly wages for each industry were taken from the ONS earnings and employment from PAYE Real Time Information dataset [13]. These were used to value the productivity loss from sickness absence. Median wage was used as this is not as sensitive to outliers as the mean is. The median weekly wages by industry are shown in the second column of Table 2.5.

Scenarios were also run using the mean wage and minimum wage. Minimum wage required taking the hourly minimum wage and multiplying it by the average number of working hours per week by industry. Mean wages used are shown in the third column of Table 2.5. Minimum weekly wages are shown in the final column of Table 2.5.

Table 2.5: Weekly wages by industry

Industry	Median weekly wage[1]	Average weekly wage[2]	Minimum weekly wage[3]
A Agriculture, forestry and fishing	£512	£642	£480.48
B Mining and quarrying	£1,045	£896	£427.86
C Manufacturing	£647	£828	£408.41
D Energy production and supply	£982	£896	£427.86
E Water supply, sewerage and waste	£698	£896	£427.86
F Construction	£592	£848	£417.56
G Wholesale, retail and repair of motor vehicles	£450	£650	£352.35
H Transport and storage	£637	£717	£399.26
I Accommodation and food services	£303	£582	£290.58
J Information and communication	£861	£1,092	£407.26
K Finance and insurance	£870	£1,025	£385.53
L Real estate	£560	£1,025	£385.53
M Professional, scientific and technical activities	£695	£992	£388.96
N Administrative and support services	£494	£731	£362.65
O Public administration and defence; social security	£684	£793	£376.38
P Education	£548	£745	£297.44
Q Human health and social work activities	£532	£682	£342.06
R Arts, entertainment and recreation	£376	£780	£328.33
S Other services	£421	£780	£328.33
T, U Households and extraterritorial	£275	£780	£328.33

1 RTINSANOV2024 dataset [13]. Three-month average of median monthly wage was taken (July to September 2024). This was divided by 30.67 (average days in a month) and multiplied by 7 to get weekly wages.

2 ONS EARN07 dataset [14]. Jul-Sep wages. The following industries are grouped in this dataset: B, D, E; K, L; R, S, T.

3 Minimum wage (April 2024): UK Government [15]. Hours worked: ONS HOUR03 dataset [16]. The following industries are grouped in this dataset: B, D, E; K, L; R, S, T.

2.3.2.3 Sick leave

It was assumed that people off work due to their MSK condition were off work for the duration of the time they spent waiting to see a physiotherapist. The average waiting time to see an MSK physiotherapist was calculated using the Community Health Services Waiting List dataset from NHS England [17]. Since these data are reported categorically as a time range, the midpoint of each range was used as the average time waited by people in each cohort. For people waiting 52 weeks and above, it was assumed that they waited 52 weeks, to avoid overestimation. The proportion of people falling into each range of weeks waiting were multiplied by these midpoints to get a weighted average waiting time of 10.95 weeks. This was rounded to 11 weeks in the Markov model to align with the weekly cycles. This information is reported in Table 2.6.

Table 2.6: MSK physiotherapy waiting times

Number of weeks waiting	Mid-point (weeks)	Proportion of waiting list
0 to 1 weeks	0.5	8.7%
1 to 2 weeks	1.5	9.5%
2 to 4 weeks	3.0	16.1%
4 to 12 weeks	8.0	38.1%
12 to 18 weeks	15.0	12.6%
18 to 52 weeks	35.0	14.3%
52 weeks and above	52.0	0.6%
Average	**10.95**	

Scenarios were also run that considered increasing the waiting time for a physiotherapist to 18 and 24 weeks, to reflect areas with longer waiting times.

The average waiting time to see a chiropractor was calculated using an unpublished survey conducted by the BCA about additional appointments available with their members. The survey had 93 respondents. Similarly to the MSK physiotherapy dataset, these data are reported categorically as a time range. Therefore, the midpoint of each range was used as the average time waited by people in each cohort. For people waiting less than one week, it was assumed that they waited one week. For people that waited more than four weeks, it was assumed that they waited five weeks. The proportion of respondents falling into each range of waiting times were multiplied by these midpoints to get a weighted average waiting time of 1.5 weeks. This was rounded to 2 weeks in the Markov model to align with the weekly cycles. This information is reported in

Table 2.7: Chiropractor waiting times

Number of weeks waiting	Mid-point (weeks)	Proportion of waiting list
0 to 1 weeks	1.0	69.9%
1 to 2 weeks	1.5	17.2%
2 to 4 weeks	3.0	5.4%
Over 4 weeks	5.0	7.5%
Average	**1.5**	

2.3.2.4 Capacity

Current capacity in chiropractic was taken from an unpublished survey conducted by the BCA about additional appointments available with their members. The survey had 93 respondents. This was then scaled up to the current number of BCA members [18]. The number of additional appointments available per week was reported as categorical data, so a mid-point was used for each numerical range. These were then weighted by the proportion who selected each answer. This question only applied to the respondents who said they had additional capacity. Therefore, the number of chiropractors was multiplied by the proportion that said they have capacity. This figure was multiplied by the weighted average number of available appointments each week to estimate the total number of available appointments per week. That was scaled up to one year using the number of working weeks per year (assumed to be the same as physiotherapists as reported by the PSSRU) [19]. That was divided by the average number of chiropractic appointments that people have for chronic low-back and neck pain, reported by Heman et al. 2021 [20] to estimate the number of people that chiropractors would be able to treat, given current capacity.

Two additional scenarios were also run with alternative figures for the number of appointments per person and the number of chiropractors with additional capacity. The average number of appointments per person was altered to the average number of physiotherapy appointments per person, based on the assumption that chiropractors would administer the same treatment as physiotherapists. This parameter was taken from a report from the Chartered Society of Physiotherapy [21]. The number of chiropractors with additional capacity was increased by assuming that the survey results from the BCA would apply to the whole chiropractic population registered with the General Chiropractic Council (GCC), i.e. only those registered as currently practicing [22].

The base-case inputs are shown in Table 2.8. The inputs for the alternative scenarios are reported in Table 2.9.

Table 2.8: Chiropractic capacity inputs

Input	Value	Source
Number of chiropractors (registered with the BCA)	2,000	BCA [18]
Percentage with capacity	80.7%	BCA capacity survey (unpublished)
Weighted average number of additional appointments per week per chiropractor with capacity	9.90	
Number of appointments per person	6.00	Heman et al. [20]
Working weeks per year	43	PSSRU [19]
Total annual capacity	**114,424**	

BCA: British Chiropractic Association.

Table 2.9: Chiropractic capacity scenarios

Input	Value	Total capacity	Source
Number of chiropractors (registered with the GCC)	3,499	200,185	GCC [22]
Number of appointments per person	3.31	207,415	JJ Consulting and Chartered Society of Physiotherapy [21]

GCC: General Chiropractic Council.

2.3.3 Markov model

A simplified Markov model was constructed to provide additional robustness to the initial analysis. Markov models use health states to represent the possible consequences of interest. Individuals move (‘transition’) between states as their condition changes over time. A schematic of the model is shown in

Figure 2.1. Time is considered in discrete time periods called ‘cycles’, which were one week long in the model, and movements from one state to another (in the subsequent time period) are usually represented as transition probabilities. Time spent in each state for a single model cycle was associated with a cost relating to lost productivity. The model takes a cohort of people who could be treated using chiropractic and compares their costs and outcomes based on what would have happened if they were waiting for physiotherapy instead. The total lost productivity associated with being off work can be compared between the chiropractic and physiotherapy-only groups.

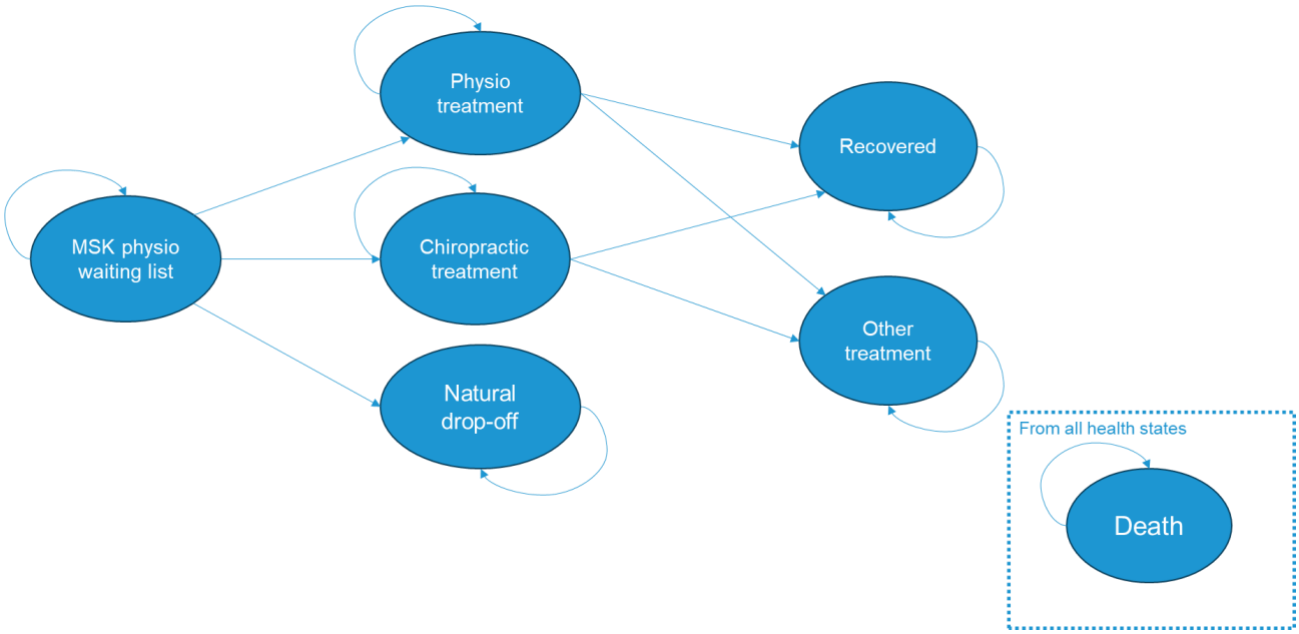
The following health states were used in the model:

- Being on the MSK physiotherapy waiting list.
- Being treated by a physiotherapist. People move here from the waiting list state.
- Being treated by a chiropractor. People move here from the waiting list state.
- Natural drop-off. People move here from the waiting list state if they leave the waiting list for any reason other than physiotherapy or chiropractic treatment. This may be because symptoms have resolved, they choose not to engage with the health system, they access private treatment, or symptoms get worse and they require alternative treatment. People are assumed to remain in this state for the remainder of the time horizon.
- Recovered. People move here from physiotherapy or chiropractic treatment when the treatment is successful. At this point, they return to work. People are assumed to remain in this state for the remainder of the time horizon.
- Other treatment. People move here from physiotherapy or chiropractic treatment when the treatment is complete. At this point, they have completed treatment but have not recovered and require further healthcare interventions. People are assumed to remain in this state for the remainder of the time horizon.
- Death. People can move here from any state. This reflects natural mortality. There is no additional mortality risk associated with different states.

The Markov model was set up to consider one person transitioning through the model over a time horizon equal to the waiting time for an MSK condition-related physiotherapy appointment. The result was then scaled up to an annual cohort of 114,424 people i.e. the annual chiropractic capacity in the base case analysis. Therefore, all people going through one model arm move from the waiting list to treatment at the same time.

People only remain in the treatment state for one cycle. This was because it was assumed that the treatment length would be the same in both groups and, therefore, would not impact the change in productivity.

Figure 2.1: Markov model structure



2.3.3.1 Additional inputs

Some additional inputs and assumptions were required to set up the Markov model. First, an average age was required to find the background all-cause mortality rate. This was calculated using the population figures reported in

Table 2.2. It was assumed that, within age groups, the probability of having an MSK condition was the same for each age e.g. a 21-year-old had the same probability as a 22-year-old. The average age was estimated to be 47 years old.

A split by gender was also required. Versus Arthritis report that 11.6 million women and 8.7 million men live with an MSK condition [8]. This equates to an MSK population that is 57.1% female.

All-cause mortality by gender is reported by the ONS [23]. Annual mortality is 0.29% for a 47-year-old male and 0.19% for a 47-year-old female. We weighted this by the male and female MSK populations to get an annual mortality of 0.235%. We then converted this to an annual

rate to work out the weekly (cycle) rate. The final weekly background mortality probability was 0.005%.

These inputs are summarised in Table 2.10.

Table 2.10: Markov model inputs

Input	Value
Average age	47
Proportion female	57.1%
Background weekly mortality	0.005%

Because no robust transition probabilities were available for the transition matrices, several scenarios were considered to understand how the results would change using different probabilities. The base-case parameter for the probability of recovery was taken from a Portland Wellness Care article. However, the reported value was unreferenced [24]. The base-case parameter for the annual probability of drop-off used the non-attendance rate reported by Brighton and Sussex University Hospitals NHS Trust [25]. Probability inputs are reported in Table 2.11.

Table 2.11: Markov model probabilities

Input	Value	Source
Probability of recovery	70%	Portland Wellness Care [24]. Reported 68-72% success rate – midpoint taken.
Percentage annual drop-off	12.22%	Prudden 2020 [27].

2.3.4 Assumptions and limitations

The results of the analysis are based on the assumption that there are equivalent work-related outcomes associated with MSK physiotherapy and chiropractic care. The literature review was used to validate the logic behind this assumption. The results of the literature review are reported in Section 3.1. Since no robust evidence was found to contradict this assumption, and since some studies reported improved work-related outcomes from chiropractic care, this assumption was considered to be reasonable by the study team. Evidence for comparison of the effectiveness of chiropractic and osteopathic care in terms of work-related outcomes was limited.

The analysis was conducted as if a portion of people receive chiropractic care and are seen in 1.5 weeks rather than 11 weeks. In reality, it is likely that these time savings would be spread across the whole waiting list population in smaller amounts. However, this would not affect the overall cost savings, only the distribution of the savings across the population.

In the initial, simple analysis, it was also assumed that treatment would be successful for all people. This is unlikely to be the case. This was addressed in the Markov model. However, a robust value for probability of recovery was not found. Therefore, several scenarios varying probability of recovery were considered. Details of the analysis using the Markov model are reported in Section 2.3.3.

It was assumed that people on sick leave would be absent from work for the duration of their time spent on the waiting list. This is unlikely to be the case for everybody and is therefore a limitation of this analysis.

The analysis has some additional limitations. Firstly, given uncertainty around some of the input parameters, conservative values were used which may result in an underestimation of the potential economic productivity benefits of using chiropractors to address NHS waiting lists.

Additionally, the analysis does not consider quality-of-life (QOL) data because this was considered out of scope for the current evaluation. However, there may be some QOL gains associated with reducing the time spent waiting for treatment. There may also be different QOL impacts associated with chiropractors versus physiotherapists. Studies of these impacts were limited and so it is recommended that further research be published before any kind of cost-effectiveness analysis is performed.

It was assumed that everyone who is on sick leave due to their MSK condition is on the MSK physiotherapy waiting list. In reality, it is likely that some people will be on a surgical waiting list and others may not be on any waiting list. However, since chiropractic capacity is much lower than the total population assumed to be on the waiting list, it is unlikely that the true demand would be fully met even with a smaller population. Therefore, this limitation is unlikely to affect any monetary results.

It was assumed that all of the chiropractic capacity available would be utilised to address waiting lists. However, in reality this is unlikely to be the case given variations in demand and capacity across different regions.

The Markov model uses a simple structure and transition probabilities are primarily assumptions. As such, it is unlikely that this model truly captures the complex nature of the waiting list. However, this simple Markov structure still allows for considerations of wider factors that may affect waiting times and provides a complimentary analysis that increases the robustness compared with the initial simple analysis. In taking into account factors such as the potential for treatment to be unsuccessful, the Markov model provides a more reasonable estimate of the value of the productivity gain that might be expected if chiropractic capacity could be used to help meet demand for MSK treatment.

Both the initial analysis and the Markov model are static rather than dynamic. This means that the analyses represent a snapshot in time and inputs are fixed. The analysis does not simulate real-time interactions and so does not capture any wider implications for the total waiting list that seeing a proportion of people faster may have.

2.3.5 Scenario analysis

In addition to the base case analysis, analyses were conducted to test the ‘uncertainty’ of the parameter values used. The potential impact of this uncertainty was explored through a series of scenarios based on a range of data points and deterministic sensitivity analysis (DSA). Data values taken from the literature were varied around the base case point estimate, using confidence intervals where possible. Where confidence intervals were unavailable, plausible ranges were estimated. The scenarios were only conducted in the Markov model since this calculated more reasonable estimates of productivity gains.

The values that were varied in the DSA were:

- MSK condition prevalence (age bands 20 to 34, 35 to 44, 45 to 54, and 55 to 64).
- Employment rate in working-age people with an MSK condition.
- Sick-leave rate in people with an MSK condition who are working.
- Number of available appointments per week per chiropractor.
- Number of appointments required per person.
- Number of chiropractors available.

It was not possible to vary the average waiting time for physiotherapists and chiropractors in the Markov model, but physiotherapist waiting times were explored through alternative scenarios.

Where more than one potential value was available for inputs, a series of alternative scenarios were run to test the impact that using different values would have on the results. The list of scenarios that were explored is provided in Table 2.12.

To vary assumptions made about the probabilities used in the Markov model, a 'liberal' and a 'conservative' scenario were run. The liberal estimates used values that were more optimistic, compared with the base case. The conservative estimates used values that were more pessimistic, compared with the base case.

The scenario using liberal probability estimates in the Markov model used the disability recurrence from those being treated mostly by physiotherapists, from the Cifuentes study [26] as the probability of recovery. It used an assumption of the probability of natural drop-off of 5%.

The scenario using conservative probability estimates in the Markov model used an assumption of the probability of recovery of 50%. It used the percentage not attending their first appointment for MSK physiotherapy, reported by Tan et al [27] as the probability of natural drop-off.

Table 2.12: Scenario analyses

Scenario	Base case value	Scenario value	Scenario source
Longer average waiting time for MSK physiotherapist	10.95 weeks	18 weeks, 24 weeks	Anecdotal evidence based on experience locally by BCA members.
Conservative estimates: increased probability of natural drop-off and reduced probability of recovery	Recovery probability: 70% Natural drop-off probability: 12.22%	Recovery probability: 50% Natural drop-off probability: 23.76%	Recovery: conservative assumption Drop-off: [27]
Liberal estimates: reduced probability of natural drop-off and increased probability of recovery	Recovery probability: 70% Natural drop-off probability: 12.22%	Recovery probability: 83.10% Natural drop-off probability: 5%	Recovery: [26] Disability recurrence of 16.9% reported for those who mostly saw physiotherapists. Drop off: liberal assumption
People require the number of appointments they would need with a physiotherapist	6.00 appointments	3.31 appointments	[21]
The BCA capacity survey is representative of all those registered with the GCC	2000 chiropractors in the population	3499 chiropractors in the population	[22]
Average weekly wage is used	Reported in Table 2.5, Column 2	Reported in Table 2.5, Column 3	[14]
Minimum wage is used	Reported in Table 2.5, Column 2	Reported in Table 2.5, Column 4	[16]

BCA: British Chiropractic Association, GCC: General Chiropractic Council, LFS: Labour Force Survey, MSK: musculoskeletal.

2.3.5.1 Future capacity

A scenario was also run to consider potential future capacity. Capacity and demand were considered for the year 2028 because this is five years after the latest chiropractic figures reported by the GCC [22], and the projected UK population for that year has been estimated by the ONS [28]. It should be noted that the ONS did not stratify the population by age and so the analysis assumes the same proportion of people in each age band. This does not account for additional considerations such as an aging population and any changes in the type of demand for and supply of physiotherapy overtime.

Future capacity was calculated by collating data from the GCC about the number of practicing chiropractors from 2015 to 2023 and using Microsoft Excel's forecasting tool. Given that the projected future capacity uses data from the GCC, these were compared with the scenario that applies the BCA capacity survey to all chiropractors registered with the GCC.

This scenario was considered to account for growth in the chiropractic profession. It does not take into account universities setting up new chiropractic degrees which may further increase this population. The projected population figures are shown in Table 2.13. The projected population of practicing chiropractors is shown in

Table 2.14. This is displayed graphically in

Figure 2.2.

Table 2.13: Projected 2028 UK population with MSK conditions

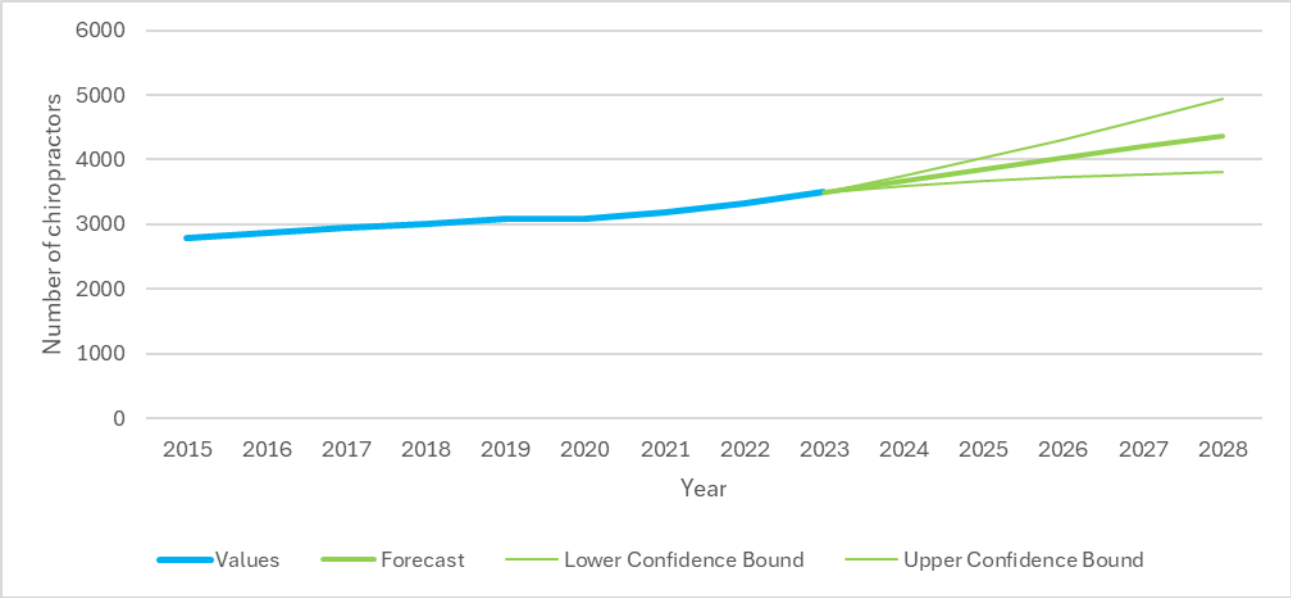
Age group	Proportion of current population	Estimated 2028 population	Estimated employed MSK population
Under 20	22.9%	16,287,030	
20 to 34	19.4%	13,755,317	1,389,012
35 to 44	13.3%	9,446,688	1,571,173
45 to 54	12.5%	8,909,290	2,116,847
55 to 64	12.9%	9,159,751	2,774,855
65 to 74	9.7%	6,874,980	
75 to 84	6.7%	4,791,174	
85 and over	2.5%	1,775,770	
Total		**71,000,000**	**7,851,887**
Total number off sick due to an MSK condition	**1,648,896**		

MSK: musculoskeletal.

Table 2.14: Projected 2028 population of practicing chiropractors

Year	Reported number of practicing chiropractors	Projected number of practicing chiropractors	Lower confidence interval	Upper confidence interval
2015	2,788			
2016	2,873			
2017	2,956			
2018	3,006			
2019	3,085			
2020	3,093			
2021	3,186			
2022	3,326			
2023	3,499			
2024		3,671	3586.43	3755.16
2025		3,847	3672.89	4020.18
2026		4,022	3736.00	4308.57
2027		4,198	3780.84	4615.22
2028		4,374	3809.93	4937.62

Figure 2.2: Projected number of chiropractors in the UK



3 Economic Analysis

3.1 Literature Review

1,270 records were retrieved from the database searches and 41 records were sent by the BCA. 101 duplicates were removed, and the remaining 1,210 references were screened for inclusion. 18 studies met the eligibility criteria and were included in data extraction (see Appendix B for the study flow diagram).

Included studies had the following study designs: five systematic reviews [29-32] (of which one was only a summary [33]), three non-systematic reviews [34, 35] with one running a meta-analysis [36], five randomised controlled trials [37-41], three cohort studies [42-44], and two case series studies [26, 45].

3.1.1 Chiropractic equivalence in outcomes

Of the studies included, only two directly compared chiropractic and physiotherapy outcomes: a cohort study [42] and a case series study [26]. Blanchette et al. 2017 found that when compared with medical doctors, chiropractors were associated with shorter durations of medical compensation from the Workplace Safety and Insurance Board, and physiotherapists with longer ones [42]. Physiotherapists were also associated with higher odds of a second episode of financial compensation. The main limitation of this study was that it considered the first healthcare professional that a person was treated by, which may not be the 'main' one they were treated by. The other limitation is that the study could not completely rule out any confounding by indication due to being unable to compare variables to established functional status questionnaires.

The other study comparing physiotherapists and chiropractors was Cifuentes et al 2011 [26]. This study found that in work-related non-specific lower back pain, the use of health maintenance care provided by a physical therapist or physician services was associated with higher disability recurrence than in chiropractic services or no treatment. The main limitation of this study was the potential casemix bias, in that there may have been differences between people that visited each provider type that affected their outcomes.

One systematic review from IJzelenberg et al. (2023) compared the outcomes of a specific treatment (spinal manipulative therapy (SMT)) with other treatments and no treatment for non-specific lower back pain, some of which were carried out by chiropractors [29]. One of the included studies compared chiropractors administering SMT with physical therapy and found similar effects on return to work. This study was associated with a high risk of bias in blinding and intention-to-treat analysis. Due to the small number of studies per treatment type, a subgroup analysis could not be performed and so the review only analysed SMT delivered by any practitioner compared with any other treatment.

A randomised controlled trial by Bogefeldt et al. 2008, whilst not comparing physiotherapists or osteopaths with chiropractors in the trial, did conduct a short review of previous studies that evaluated comprehensive manual therapy for lower back pain and its effect on sick leave [38]. It was not possible to analyse these studies in depth in the timeframe, but the paper reported summaries of three studies evaluating chiropractic treatment and physiotherapy treatment that concluded equivalent outcomes associated with sick leave between the two groups.

Other included studies evaluated specific treatments rather than the healthcare professional administering them [32, 33, 35, 37, 39, 45]. These were included because they were treatments that a chiropractor could perform. Treatments tended to be performed by physiotherapists, or the clinician was not reported. These studies suggested that treatments that can be administered by chiropractors would have similar or better work-related outcomes to the comparators (for example, multimodal rehabilitation versus standard care in a primary care setting [45]).

Some studies that were included matched the eligibility criteria but did not report the results in a way that was useful for analysis. For example, Maas et al. 2024 analysed the societal costs of older adults with lower back pain seeking chiropractic care and included absenteeism and presenteeism [44]. However, no length of sick leave or quantitative reduction in productivity was reported, nor did it include a control group, meaning that the results could not be used in this analysis. Another example was a systematic review that searched for return-to-work outcomes as part of the review, but none were found [32].

Seferlis et al. 1998 [40] was the only study reviewed that suggested that chiropractors may not have equivalent or better work-related outcomes to some form of standard care. The study compared a multidisciplinary manual therapy-centred programme, an intensive training programme, and a GP programme. The multidisciplinary programme showed slightly more days of sick leave on average compared with the other two programmes. However, it was unclear in the reporting if this was intended to be a characteristic of each group or an outcome that was affected by treatment. Additionally, the number of people reporting recurrence of pain within the study year was similar across groups. No statistical significance was reported for either of these outcomes.

The pragmatic literature review, therefore, found no robust evidence to suggest that chiropractors would not produce similar or better work-related outcomes than MSK physiotherapists or osteopaths. The review has been used as evidence to inform the logic of the assumption in the analysis that chiropractors have equivalent work-related outcomes to MSK physiotherapy.

3.1.2 Recommendations

This was a pragmatic review and therefore some relevant studies will have been missed, such as those summarised by Bogfeldt et al [38]. Given this, it is recommended that a systematic review be conducted in the future to provide a more robust review of the evidence base.

Additionally, very few studies were retrieved that directly compared work-related outcomes of chiropractors and physiotherapists and they were not randomised controlled trials which are considered the most robust study design for primary studies comparing interventions [46]. Therefore, it is recommended that further robust primary studies are published in this area of research.

3.2 Waiting Lists

The proportion of the waiting list that chiropractors could address annually is reported in Table 3.1. If chiropractors have capacity to treat an additional 114,424 people per year, this is estimated to address 7.2% of the waiting list. If the population was limited to conditions listed by the ASA, 114,424 people would account for 14.4% of the waiting list population.

Table 3.1: Proportion of waiting list addressed

	Whole MSK waiting list	Population eligible for treatment by chiropractors
Population size	1,585,384	792,692
Number treated	114,424	114,424
Proportion treated	**7.2%**	**14.4%**

3.3 Productivity

Results of the initial simple analysis estimate that if chiropractors treated an additional 114,424 people on the MSK waiting list per year, that could result in a workforce productivity gain of £612 million, an average of £5,349 per treated person. Alternatively, this is a productivity gain of £386 per person on the waiting list.

A breakdown of the productivity gains by industry are shown in Table 3.2. It is estimated that the largest saving would be in the human health and social work industries, due to them making up the largest proportion of those with sickness absence due to MSK conditions.

Table 3.2: Productivity gains by industry

Industry	Productivity gains
A Agriculture, forestry and fishing	£3,730,604
B Mining and quarrying	£967,813
C Manufacturing	£71,094,270
D Energy production and supply	£2,156,457
E Water supply, sewerage and waste	£3,409,214
F Construction	£65,046,524
G Wholesale, retail and repair of motor vehicles	£58,853,154
H Transport and storage	£37,836,853
I Accommodation and food services	£11,687053
J Information and communication	£25,902,980
K Finance and insurance	£20,670,439
L Real estate	£7,143,161
M Professional, scientific and technical activities	£39,239,170
N Administrative and support services	£39,623,511
O Public administration and defence; social security	£48,757,304
P Education	£53,717,753
Q Human health and social work activities	£96,483,440
R Arts, entertainment and recreation	£7,828,015
S Other services	£17,483,014
T, U Households and extraterritorial	£354,830
Total	**£612,000,559**

3.4 Markov Model Results

The results estimated using the Markov model also indicate a productivity benefit from using chiropractic treatment, however, the magnitude of the results is smaller than the high-level analysis. This is due to the fact that people on the waiting list in the physiotherapy group are able to move to a treated state, and therefore return to work, before the average waiting time to be seen by a physiotherapist. It also accounts for natural drop-off from the waiting list, and a less than 100% probability of recovery. The base-case results show a productivity gain equivalent to £399 million using median wage and assuming an average waiting list length of 11 weeks for physiotherapists and a waiting list length of 2 weeks for chiropractors. This translates to a productivity gain value of £3,489 per person in the model cohort. These results are displayed in Table 3.3.

Table 3.3: Base-case results of the Markov model

	Chiropractors	Physiotherapists only	Incremental
Total lost productivity	£355,141,646	£754,402,712	-399,261,066*
Productivity loss per person	£3,104	£6,593	-£3,489

* This is a negative loss in productivity i.e. a productivity gain.

3.5 Sensitivity Analysis

3.5.1 Deterministic sensitivity analysis

The results of the DSA suggest that the variables where uncertainty would have the largest (any) impact on the results were:

- Number of appointments per person.
- Number of practising chiropractors.
- Number of appointments available weekly per chiropractor.

This follows sensible intuition as these inputs all impact the amount of time that people are absent from work, and the number of people who can be treated annually.

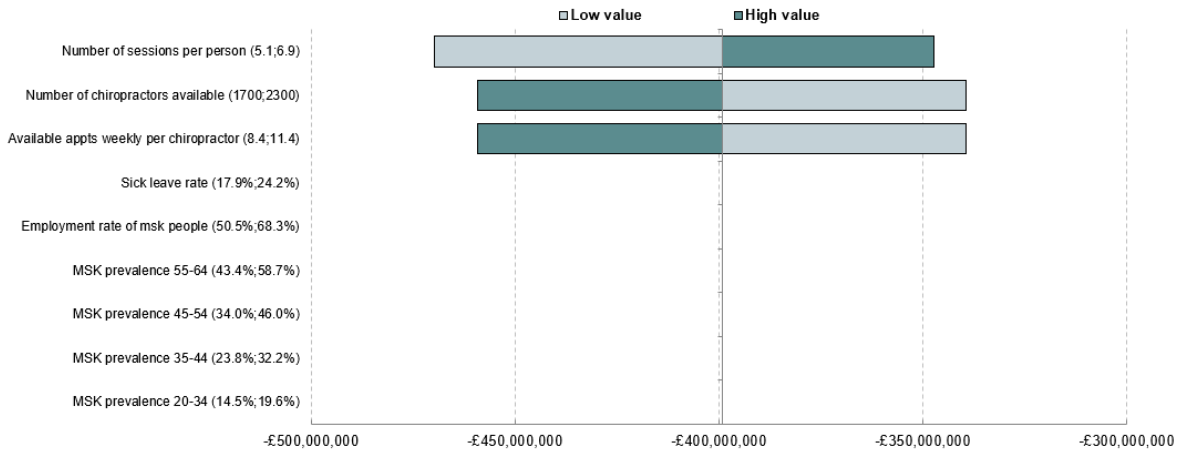
The potential uncertainty of the following variables had no impact on the results:

- Proportion of people with MSK conditions who take sick leave.
- Employment rate of people with MSK conditions.
- MSK prevalence for all age groups.

This is because they impact the size of the waiting list. Given that chiropractic capacity is much smaller than the waiting list size, this has no impact on the number of people that they would treat.

Figure 3.1 shows a tornado diagram that displays these results graphically. As cost of treatment is not considered in this analysis, varying the results only impacts the size of the productivity gains, not the direction.

Figure 3.1: Tornado diagram



3.5.2 Scenario analysis

Using conservative estimates of the probability of recovery and natural drop-off decreased the total potential productivity gains, due to fewer people receiving successful treatment. Conversely, using liberal estimates of the probability of recovery and natural drop-off increased the total potential productivity gain.

Running a scenario where physiotherapy waiting lists were longer demonstrated a larger increase in potential productivity gains. This is due to the assumption that people are off work for the duration of their time on the waiting list.

Decreasing the number of appointments required per person increased the estimated chiropractic capacity, which means they could treat 13.1% of the waiting list. This could result in productivity gains of £723,736,071.

Using average wages also increased the potential productivity gain. This is because mean wages tend to be higher than median wages as they are more sensitive to outliers. Conversely, using minimum wages decreases the potential gains. However, it does allow understanding of the minimum productivity gains from people returning to work nine weeks earlier.

A summary of the results of the scenario analysis are reported in

Table 3.4.

Table 3.4: Summary of scenario results

Scenario	Total productivity gain	Productivity gain per person
Base case	£399,261,066	£3,489.31
Conservative estimates: reduced chance of recovery and increased chance of dropping off waiting list	£280,617,710	£2,452.44
Liberal estimates: increased chance of recovery and decreased chance of dropping off waiting list	£478,730,663	£4,183.84
18-week wait for a physio	£712,711,580	£6,228.70
24-week wait for a physio	£999,976,979	£8,739.24
3.31 appointments required per person	£723,736,071	£3,489.31
Applying the capacity survey to all practicing chiropractors registered with the GCC (3499)	£698,507,235	£3,489.31
Average wages used	£544,198,646	£4,755.99
Minimum wages used	£257,725,634	£2,252.38

3.5.3 Future capacity

The projected increased number of chiropractors each year compared with projected population growth would mean that in 2028 an additional 15.2% of the waiting list could be addressed or 250,245 people. This could produce productivity gains of £873 million. Table 3.5 shows these results, comparing them with current estimated capacity with practicing chiropractors registered

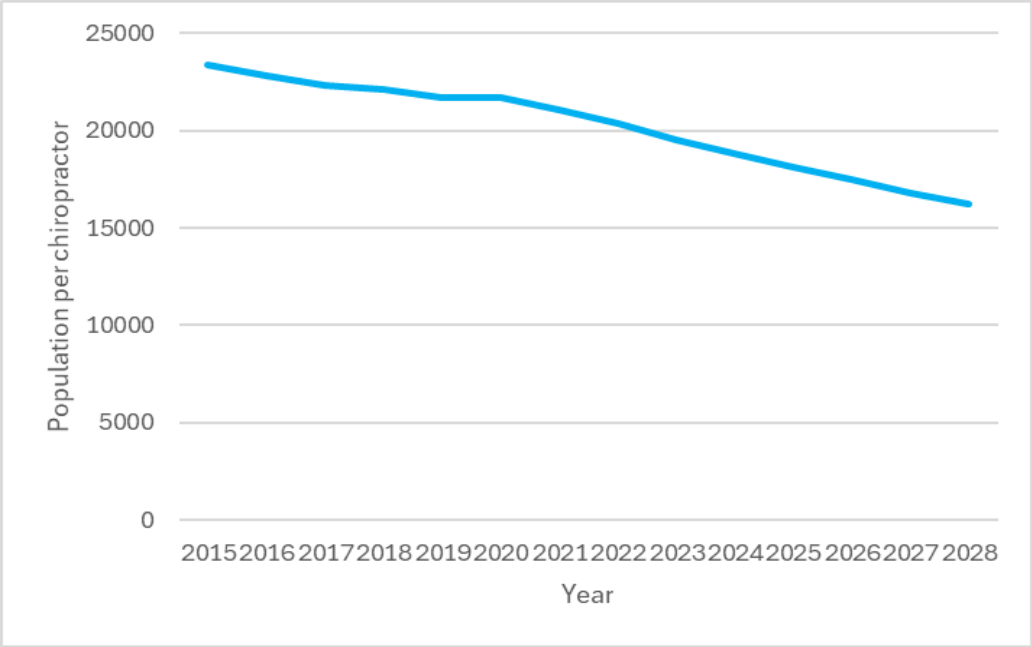
with the GCC. Figure 3.2 visualises the historical and projected number of people per chiropractor in the UK population.

Table 3.5: Future capacity scenario results

	Annual capacity	Proportion of waiting list	Total productivity gain
Current GCC figures	200,185	12.6%	£698,507,235
2028 projected GCC figures	250,245	15.2%	£873,183,952
Increase	**50,060**	**2.6%**	**£174,676,717**

GCC: General Chiropractic Council.

Figure 3.2: Projected population per chiropractor over time



4 Discussion

4.1 Conclusions

Sickness absence in the workforce has been estimated to be responsible for more than £100 billion of lost productivity in the UK every year. More than a quarter of workforce sickness absence relates to MSK conditions. There are long waiting lists for treatment by physiotherapists for people with MSK conditions, with waiting times of at least 11 weeks in many parts of the country.

The BCA believes that spare capacity in the chiropractic workforce could be used to help to reduce waiting times and to get people back to work more quickly. Chiropractors are not currently classified as AHPs and so are not included in the NHS MSK strategy.

A pragmatic review of literature found that evidence of the effectiveness of chiropractors in helping people with MSK conditions to get back to work is sparse and poor quality. There is weak evidence to suggest that chiropractors treating MSK conditions would be able to achieve equivalent return-to-work outcomes as physiotherapists. If more robust evidence could be developed, it is feasible that chiropractors could be used to address supply shortages in treatment for MSK conditions. This would require the NHS to consider closely the clinical governance arrangements it would need to put in place to ensure patient safety. It would also need to review the type of treatment and advice that chiropractors were able to provide for people with MSK conditions.

The initial analysis carried out for this study estimated that there are almost 1.6 million people unable to work due to an MSK condition in the UK. Spare capacity in the chiropractic profession indicates that around 114,000 more people per year could be treated by chiropractors. This represents around 7% of the current waiting list. Chiropractors have an average waiting time of 1.5 weeks compared with a minimum of 11 weeks for physiotherapists.

If the spare chiropractor capacity was used to address MSK conditions preventing people from working, then this could improve workforce productivity by reducing the time people are waiting for treatment. Adopting a simple analysis, assuming that all of the spare capacity could be used in the most efficient way, the estimated value of the improvement in productivity is £612 million per year. Using the Markov model to factor in a wider range of potential outcomes provides a more conservative, more robust estimated value of £399 million per year.

If minimum rather that median wages are used to value the productivity gain based on an 11-week wait then it would reduce to £258 million.

A range of factors may increase or decrease the potential productivity gains. If the 11-week waiting time for physiotherapists is an under-estimate and the waiting times are 18 or 24 weeks, then the productivity gain would increase to £713 million and £1 billion respectively.

This analysis focused on productivity costs only, but people may also potentially have better health outcomes and lower treatment costs if they are treated more quickly.

4.2 Recommendations

Key recommendations emerging from this research are:

- The NHS should consider commissioning pilot research studies to generate evidence to make the case for the use of chiropractors in providing treatment for people with MSK conditions to allow them to return to work more quickly.
- The NHS should consider how the potential use of chiropractors to provide treatment and advice for people with MSK conditions can help to address the demand, capacity and financial challenges facing the health and social care system. This would need to be within the constraints of clinical guidelines and governance, to ensure safety and effective outcomes.

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Appendix A

Ovid MEDLINE Search Strategy

1	musculoskeletal pain/	5011
2	(musculoskeletal or musculo skeletal or MSK or MSD).ti,ab,kf.	84907
3	or/1-2	86442
4	exp osteoarthritis/	82659
5	(arthroses or arthrosis or degenerative arthritis or osteoarthrit* or osteoarthros*).ti,ab,kf.	108945
6	or/4-5	129207
7	back pain/	19385
8	low back pain/	28372
9	radiculopathy/	6110
10	polyradiculopathy/	2601
11	spondylitis, ankylosing/	17073
12	exp spondylolysis/	6318
13	intervertebral disc displacement/	20892
14	intervertebral disc degeneration/	8445
15	(back ache* or backache* or backpain*).ti,ab,kf.	4324
16	((radicular or lumbal or lumbar or lumbosacral or sacral or sacrum or sacroiliac or lumbosacroiliac or spine* or coccyx or coccygeal or spinal or back or backs or thoracic or vertebra* or vertebro*) adj3 (pain* or strain* or stenosis or stenoses or stenot* or arthrit* or syndrome* or myelopath* or myelitis)).ti,ab,kf.	103849
17	(radiculitis or radiculopath* or polyradiculopath*).ti,ab,kf.	10065
18	((ankylosing or ankylopoietica or rheum*) adj3 (spondylarthritis or spondylitis or spondyloarthritis)).ti,ab,kf.	19487
19	(bechterew* or struempell*).ti,ab,kf.	611
20	(coccydynia* or dorsalgia* or lumbago or lumbalgesi* or lumbalgi* or lumbodynia*).ti,ab,kf.	2158
21	((disc or disk) adj3 (herniat* or degen* or degrad* or protrude* or protrus* or prolapse* or slip*)).ti,ab,kf.	26997
22	spondyloarthropath*.ti,ab,kf.	3327
23	(spondylolysis or spondylolisthesis or spondylolysis or olisthesis or spondylisthesis).ti,ab,kf.	7859
24	scoliosis/ or kyphosis/ or scheuermann disease/	27327
25	(scoliosis or kyphosis or scheurmann* or hyperkyphosis).ti,ab,kf.	35901
26	or/7-25	214948
27	neck pain/	9123
28	((neck or cervical) adj3 (pain* or dystonia*)).ti,ab,kf.	22797
29	(cervicalgia or cervicodynia).ti,ab,kf.	223
30	(neck ache or neckache).ti,ab,kf.	56
31	or/27-30	25440
32	bursitis/	4128
33	rotator cuff injuries/	8424
34	rotator cuff tear arthropathy/	134
35	shoulder impingement syndrome/	2022
36	shoulder injuries/	5190
37	shoulder pain/	6256
38	shoulder joint/	22924
39	((shoulder* or rotator cuff*) adj3 (bursitis or tendinitis or impinge* or tear or tears or tendonitis or tendinos* or disorder* or syndrome* or pain* or unstable or instability)).ti,ab,kf.	27727
40	((acromioclavicular or glenohumeral or shoulder) adj joint*).ti,ab,kf.	11753
41	((coracohumeral or coracoid or internal or outlet or glenoid or subacromial) adj impinge*).ti,ab,kf.	1234
42	(glenoid adj (labral or labrum)).ti,ab,kf.	726
43	milwaukee shoulder*.ti,ab,kf.	54
44	((labral or labrum) adj3 tear*).ti,ab,kf.	2049
45	(slap adj (lesion* or tear*)).ti,ab,kf.	842
46	(superior labrum or superior labral).ti,ab,kf.	948

47 or/32-46 57647
48 knee/ 16610
49 knee joint/ 68871
50 knee injuries/ 20063
51 patella/ 11251
52 iliotibial band syndrome/ 91
53 anterior cruciate ligament injuries/ 14375
54 patellofemoral pain syndrome/ 1253
55 ((knee* or kneecap* or patella* or patello* or retropatella* or peripatella* or infrapatella*) adj3 (pain* or arthriti* or tendinitis or tendonitis or injury or injuries or tear or tears or syndrome*)).ti,ab,kf. 35138
56 ((iliotibial band or ilio-tibial band or IT band) adj syndrome*).ti,ab,kf. 191
57 (menisc* adj3 (tear or tears or injur*)).ti,ab,kf. 8431
58 ((acl or anterior cruciate ligament*) adj3 (injury or injuries or tear or tears)).ti,ab,kf. 9556
59 or/48-58 128508
60 3 or 6 or 26 or 31 or 47 or 59 568916
61 chiropractic/ 3539
62 manipulation, chiropractic/ 1137
63 musculoskeletal manipulations/ 2366
64 manipulation, osteopathic/ 1266
65 manipulation, orthopedic/ 4007
66 manipulation, spinal/ 1878
67 therapy, soft tissue/ 178
68 massage/7034
69 exp exercise therapy/ 68294
70 (chiropract* or chiro pract* or chirotherap* or chiro therap*).ti,ab,kf. 7227
71 ((manipulat* or mobilis* or mobiliz*) adj3 (lumbal or lumbar or lumbosacral or sacral or sacrum or sacroiliac or lumbosacroiliac or spine* or coccyx or coccygeal or spinal or back or backs or thoracic or vertebra* or vertebro*)).ti,ab,kf. 3899
72 ((manipulat* or mobilis* or mobiliz*) adj3 (osteopath* or orthoped* or orthopaed* or musculo* or skelet* or bone or bones or joint or joints or MSK or physio* or physical)).ti,ab,kf. 8035
73 ((manual or manipulat*) adj (therapy or therapies)).ti,ab,kf. 5030
74 (massage* or rolfing).ti,ab,kf. 13490
75 (soft tissue adj3 (manipulat* or mobilis* or mobiliz* or therapy or therapies or technique*)).ti,ab,kf. 2763
76 (exercise* adj3 (therapy or therapies or prescrib* or prescription* or remedial or rehab* or advice)).ti,ab,kf. 24970
77 (multi* modal* or multimodal*).ti,ab,kf. 90646
78 or/61-77 212815
79 absenteeism/ 9975
80 presenteeism/ 680
81 sick leave/ 7028
82 return to work/ 3977
83 waiting lists/ 14425
84 work/ 20256
85 employment/ 52038
86 (absenteeism or presenteeism).ti,ab,kf. 9030
87 ((sickness or illness) adj presence).ti,ab,kf. 136
88 ((sick* or illness or disabilit*) adj3 (leave* or absen* or rate*)).ti,ab,kf. 19917
89 ((work* or employment*) adj3 (leave* or absen* or disabilit*)).ti,ab,kf. 13708
90 ((sick* or illness or disabilit* or leave* or absen* or chronic* or medical*) adj3 unemploy*).ti,ab,kf. 1206
91 (medical* adj3 (leave* or absen*)).ti,ab,kf. 2305
92 ((chronic* or long term or longterm) adj3 (leave* or absen* or sick*)).ti,ab,kf. 5586
93 ((day* or week* or month* or year* or time or duration) adj (away or off or miss*)).ti,ab,kf. 9315
94 (sicklist* or sick-list*).ti,ab,kf. 779
95 (productiv* or unproductiv*).ti,ab,kf. 139257
96 (waitlist* or wait* list*).ti,ab,kf. 23830
97 ((return* or back) adj2 (work* or employ* or routine* or normal* or usual*)).ti,ab,kf. 52176
98 or/79-97 336684

99	60 and 78 and 98	1126
100	exp animals/ not humans/	5275220
101	(news or editorial or case reports).pt. or case report.ti.	3431007
102	or/100-101	8639736
103	99 not 102	1084
104	limit 103 to english language	1021

Key to Ovid symbols and commands:

*	Unlimited right-hand truncation symbol
*N	Limited right-hand truncation - restricts the number of characters following the word to N
ti,ab,kf	Searches are restricted to the Title (ti), Abstract (ab), Keyword Heading Word (kf) fields
adj	Retrieves records that contain terms next to each other (in the shown order)
adjN	Retrieves records that contain terms (in any order) within a specified number (N) of words of each other
/	Searches are restricted to the Subject Heading field
exp	The subject heading is exploded
*	The subject heading is searched as a major descriptor only
pt.	Search is restricted to the publication type field
or/1-2	Combines sets 1 to 2 using OR

Saved in Ovid as: temp - NH339 - chiro - for protocol v2

Appendix B

PRISMA Study Flow Diagram