Candidate Number: ZVBZ7

```
---
title: "The Health of a Nation"
output: html_document
---

```{r, include=FALSE}
# To be run on a Windows environment and viewed in Google Chrome
# Candidate Number: ZVBZ7
```
<style type="text/css">
.table {
    width:90% !important;
}
</style>
```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)

library(arulesViz)
library(betareg)
library(car)
library(caret)
library(dplyr)
library(fingertipsR)
library(geojsonio)
library(ggplot2)
library(htmltools)
library(leaflet)
library(mi)
library(psycho)
library(readr)
library(rmapshaper)
library(tibble)
library(tidyr)
```
```

```
# Get the indicies of multiple deprivation at LSOA level.

imd_df <-
read_csv('https://assets.publishing.service.gov.uk/government/uploads/syste
m/uploads/attachment_data/file/467774/File_7_ID_2015_All_ranks__deciles_and
_scores_for_the_Indices_of_Deprivation__and_population_denominators.csv')


# Add UTLA mapping

lsoa_utla_lookup <-
read_csv('https://opendata.arcgis.com/datasets/95ecb220a30e41d5ae759cd1c9aa
929f_0.csv')

lsoa_utla_lookup <- lsoa_utla_lookup %>%

  select(LSOA11CD, UTLA18CD)

imd_df <- merge(x = imd_df, y = lsoa_utla_lookup, by.x = 'LSOA code
(2011)', by.y = 'LSOA11CD')


# Select only the subdomain totals

pop_weighted_ave_domains <- imd_df %>%

  select("Income Score (rate)", "Employment Score (rate)", "Education,
Skills and Training Score", "Health Deprivation and Disability Score",

                 "Crime Score", "Barriers to Housing and Services Score",
"Living Environment Score",

                 "Income Deprivation Affecting Children Index (IDACI) Score
(rate)",

                 "Income Deprivation Affecting Older People (IDAOPI) Score
(rate)", "Children and Young People Sub-domain Score",

                 "Adult Skills Sub-domain Score", "Geographical Barriers
Sub-domain Score", "Wider Barriers Sub-domain Score",

                 "Indoors Sub-domain Score", "Outdoors Sub-domain Score",
"Total population: mid 2012 (excluding prisoners)")


# Create population weighted averages for each UTLA

pop_weighted_ave_domains <- pop_weighted_ave_domains[, 1:15] /
pop_weighted_ave_domains[,16]

pop_weighted_ave_domains$UTLA18CD <- imd_df$UTLA18CD

pop_weighted_ave_domains <- pop_weighted_ave_domains %>%

  group_by(UTLA18CD) %>%

  summarise_each(funs(mean))
```

```
# Create z scores of deprivation matrix and reverse polarity as low is good
on the deprivation scores

z_data_imd <- pop_weighted_ave_domains %>%

  standardize() %>%

  mutate_each(funs(-.), -one_of("UTLA18CD"))


# Get fingertips data

# Seleceted indicators from a variety of fingertips profiles selected to
fulfil the Marmot definitions of Social Determinants, Health Outcomes, and
Risk Factors


early_years_indicators <- indicators(DomainID = 1938133223)

social_determinants_df <- fingertips_data(IndicatorID =
c(as.vector(early_years_indicators$IndicatorID), 93376, 22304, 10501,
90282, 91126, 91133, 92899, 90638, 93103, 93131, 93175, 91463, 90244,
90245, 92447, 91116, 92785, 91524, 91307), rank = T)


prevalance_estimates = indicators(DomainID = 1938133099)

mortality_indicators = indicators(DomainID=c(1000044, 1000049))

extra_indicators =
as.vector(rbind(as.vector(prevalance_estimates$IndicatorID),
as.vector(mortality_indicators$IndicatorID)))

health_outcomes_df = fingertips_data(IndicatorID = c(extra_indicators,
20101, 92718, 92724, 92725, 90287, 90641), rank = T)


behav_risk_factors = indicators(DomainID=c(1938132694, 1938133001))

inds <- c(as.vector(behav_risk_factors$IndicatorID), 30101, 113, 1203,
93085, 90323, 93077, 92527, 92937, 92588, 92443)

risk_factors_df = fingertips_data(IndicatorID = inds, rank = T)


soc_dec_meta <- indicator_metadata(IndicatorID = c(IndicatorID =
c(as.vector(early_years_indicators$IndicatorID), 93376, 22304, 10501,
90282, 91126, 91133, 92899, 90638, 93103, 93131, 93175, 91463, 90244,
90245, 92447, 91116, 92785, 91524, 91307)))

risk_fac_meta <- indicator_metadata(IndicatorID = inds)

health_out_meta <- indicator_metadata(IndicatorID = c(extra_indicators,
20101, 92718, 92724, 92725, 90287, 90641))


# Function that takes in a data frame and outputs a list of analysed data
frames
```

```
analyze_df <- function(df){
  # Create a data frame of indicator polarities
  polarities <- df %>%
    select(IndicatorID, Polarity) %>%
    distinct() %>%
    spread(key = IndicatorID, value = Polarity)


  # Select as most recent for each indicator and restrict to persons rather
than include sex breakdowns
  most_recent_data <- df %>%
    group_by(IndicatorID) %>%
    filter(TimeperiodSortable == max(TimeperiodSortable)) %>%
    filter(Sex == "Persons") %>%
    ungroup()


  # Select County & UA
  most_recent_data <- most_recent_data[grep('County',
most_recent_data$AreaType), ]



  # Transpose to wide data and remove any indicators with no data
  wide_df <- most_recent_data %>%
    select(AreaCode, IndicatorID, Value) %>%
    tibble::rowid_to_column() %>%
    group_by(IndicatorID, AreaCode) %>%
    spread(key = IndicatorID, value = Value) %>%
    summarise_all(funs(na.omit(.)[1]))
  rownames(wide_df) <- wide_df$AreaCode
  wide_df <- wide_df %>%
    select(-rowid) # Remove row id column


  # Remove areas with over 50% missing data - areas with this are unlikely
to add any information as their values are more imputed than not
  wide_df$proportna <- apply(wide_df, 1, function(x) sum(is.na(x)) /
dim(wide_df)[2])
```

```
  wide_df <- wide_df[wide_df$proportna < 0.5,]
  wide_df <- wide_df %>% select(-proportna)



  # Remove indicators with over 80% missing data
  wide_df <- wide_df[colSums(is.na(wide_df)) / dim(wide_df)[1] < 0.2]



  # impute missing data - using a Bayesian framework, with 30 inerations
and 4 chains. A random seed was chosen to ensure reproducability. The
bootstrap was envoked as a method of selecting random imputations.
  # http://www.stat.columbia.edu/~gelman/research/published/mipaper.pdf
  to_impute <- wide_df
  rownames(to_impute) <- to_impute$AreaCode
  to_impute <- to_impute %>% select(-AreaCode)
  imputed <- mi(as.data.frame(to_impute), seed = 225)
  summary(imputed)
  imp_img <- image(imputed) # Show heatmap of imputed values in heatmap
  imputed_df <- mi::complete(imputed, m = 1) # Retrieve the dataframe
  imputed_df <- select(imputed_df, -contains("missing")) # Remove the
boolean 'missing' columns.


  norm_reduced <- imputed_df


  # Test colinearity - Indicators with high correlation will have 1
omitted.
  corr <- cor(norm_reduced)


  hc <- caret::findCorrelation(corr)
  hc <- sort(hc)
  if (length(hc) == 0){
    reduced_data <- norm_reduced
  } else {
    reduced_data <- norm_reduced[, -c(hc)]
  }
```

```
  # Polarity check and inversion. If 'Low is good', then the scores are
inverted to ensure the same direction of performance in the data.
  polarity_check <- function(col_name){
    if (grepl(polarities[[col_name]], "RAG - Low is good")) {
      z_data[[col_name]] <- -z_data[[col_name]]
    } else {
      z_data[[col_name]] <- z_data[[col_name]]
    }
  }

  # Create summary stats to use as the baseline measure for future years
  create_summary_stats <- function(x){
    summary_stats <- sapply(x, function(x) c( "Stand dev" = sd(x),
                          "Mean"= mean(x,na.rm=TRUE),
                          "n" = length(x),
                          "Median" = median(x),
                          "CoeffofVariation" = sd(x)/mean(x,na.rm=TRUE),
                          "Minimum" = min(x),
                          "Maximun" = max(x),
                          "Upper Quantile" = quantile(x,1),
                          "LowerQuartile" = quantile(x,0)
                    )
      )
    return(summary_stats)
  }


  # Create Z scores using psycho package's standardize() function.
  # Makowski, (2018). The psycho Package: an Efficient and Publishing-
Oriented Workflow for Psychological Science. Journal of Open Source
Software, 3(22), 470. https://doi.org/10.21105/joss.00470
  z_data <- reduced_data %>% standardize()
  names(z_data) <- substring(names(z_data), 2)
  z_data <- z_data %>%
                rename_at(.vars = vars(ends_with(".1")),
```

```
                .funs = funs(sub("[.]1$", "", .)))
  polarities <- polarities[, colnames(z_data)]



  # Create a dataframe of z-scores, create mean score & add area codes on.
  z_data <- data.frame(z_data, lapply(colnames(z_data), polarity_check))
  z_data <- z_data[, -c(1:ncol(polarities))]
  colnames(z_data) <- colnames(polarities)


  # Get metadata for indicators and set them to global variables to use
outside the function
  # Get Summary statistics for benchmarking
  metadata_to_return <- indicator_metadata(IndicatorID = colnames(z_data))
  summary_to_return <- create_summary_stats(reduced_data)
  z_data$mean <- apply(z_data, 1, mean)
  z_data$AreaCode <- wide_df$AreaCode



  # z_mean <- z_data %>% select(mean, AreaCode)
  return(list('data' = z_data, 'metadata' = metadata_to_return, 'summary' =
summary_to_return, 'imp_img' = imp_img))
}


# Pass component data frames to analyze_df and unpack results
health_outcomes_returned <- analyze_df(health_outcomes_df)
health_outcomes_processed <- health_outcomes_returned$data
health_outcomes_metadata <- health_outcomes_returned$metadata
health_outcomes_summary <- health_outcomes_returned$summary
health_outcomes_imp_image <- health_outcomes_returned$imp_img
risk_factors_returned <- analyze_df(risk_factors_df)
risk_factors_processed <- risk_factors_returned$data
risk_factors_metadata <- risk_factors_returned$metadata
risk_factors_summary <- risk_factors_returned$summary
risk_factors_imp_img <- risk_factors_returned$imp_img
```

```
# Add imd to social determinants and recalc mean

soc_det_returned <- analyze_df(social_determinants_df)

soc_det_processed <- soc_det_returned$data

soc_det_metadata <- soc_det_returned$metadata

soc_det_summary <- soc_det_returned$summary

soc_det_imp_img <- soc_det_returned$imp_img


soc_det_processed <- merge(soc_det_processed, z_data_imd, by.x =
'AreaCode', by.y = 'UTLA18CD')

soc_det_processed$mean <- apply(soc_det_processed[,
!(names(soc_det_processed) %in% c('mean', 'AreaCode'))], 1, mean)


# Create a dta frame of z_means from all the components

z_means <- data.frame(health_outcomes_processed$mean,
soc_det_processed$mean, risk_factors_processed$mean,
risk_factors_processed$AreaCode)

names(z_means) <- c("health_outcomes", "social_determinants",
"risk_factors", "AreaCode")

z_means$grand_mean <- apply(z_means[, !(names(z_means) %in%
c('AreaCode'))], 1, mean)

z_means$health_outcomes.rank <- rank(z_means$health_outcomes, na.last =
FALSE)

z_means$social_determinants.rank <- rank(z_means$social_determinants,
na.last = FALSE)

z_means$risk_factors.rank <- rank(z_means$risk_factors, na.last = FALSE)

z_means$overall.rank <- rank(z_means$grand_mean, na.last = FALSE)


# Get shape files for UTLAs

utlas <-
geojson_read("https://opendata.arcgis.com/datasets/d3d7b7538c934cf29db791a7
05631e24_0.geojson", what = 'sp')

# drop Wales

utlas <- utlas[grep('E', utlas$ctyua17cd), ]

# Reduce the size of the file

utlas <- ms_simplify(utlas)

# Add z_means to the geojson

utlas@data <- left_join(utlas@data, z_means, by = c("ctyua17cd" =
"AreaCode"))

# Set colour pallets for each of the components
```

```
pal_grand <- colorNumeric(palette = "Spectral", domain = utlas$grand_mean)

pal_soc <- colorNumeric(palette = "Spectral", domain =
utlas$social_determinants)

pal_risk <- colorNumeric(palette = "Spectral", domain = utlas$risk_factors)

pal_outcomes <- colorNumeric(palette = "Spectral", domain =
utlas$health_outcomes)

# Define labels for the map views

labs_grand_mean <- lapply(seq(nrow(utlas@data)), function(i) {

  paste0( '<p>', utlas@data[i, "ctyua17nm"], '<p></p>',

          'Health Index Score:', round(utlas@data[i, 'grand_mean'],
3),'</p><p>',

          'Rank:', utlas@data[i, 'overall.rank'], '</p>' )

})

labs_soc <- lapply(seq(nrow(utlas@data)), function(i) {

  paste0( '<p>', utlas@data[i, "ctyua17nm"], '<p></p>',

          'Social Determinants Score:', round(utlas@data[i,
'social_determinants'], 3),'</p><p>',

          'Rank:', utlas@data[i, 'social_determinants.rank'], '</p>' )

})

labs_risk <- lapply(seq(nrow(utlas@data)), function(i) {

  paste0( '<p>', utlas@data[i, "ctyua17nm"], '<p></p>',

          'Risk Factors Score:', round(utlas@data[i, 'risk_factors'],
3),'</p><p>',

          'Rank:', utlas@data[i, 'risk_factors.rank'], '</p>' )

})

labs_outcomes <- lapply(seq(nrow(utlas@data)), function(i) {

  paste0( '<p>', utlas@data[i, "ctyua17nm"], '<p></p>',

          'Health Outcomes Score:', round(utlas@data[i, 'health_outcomes'],
3),'</p><p>',

          'Rank:', utlas@data[i, 'health_outcomes.rank'], '</p>' )

})


# Create map

map1 <- leaflet(utlas) %>%

  # Base groups

  addTiles(group = "OSM (default)") %>%

  # Overlay groups
```

```
  # addCircles(~long, ~lat, ~10^mag/5, stroke = F, group = "Quakes") %>%

  addPolygons(

    weight = 2, fillOpacity = 0.8, color = ~pal_grand(grand_mean), group =
"Health Index - Total", label = lapply(labs_grand_mean, HTML)) %>%


  addPolygons(

    weight = 2, fillOpacity = 0.8, color = ~pal_soc(social_determinants),
group = "Social Determinants", label = lapply(labs_soc, HTML)) %>%

  addPolygons(

    weight = 2, fillOpacity = 0.8, color = ~pal_risk(risk_factors), group =
"Risk Factors", label = lapply(labs_risk, HTML)) %>%

  addPolygons(

    weight = 2, fillOpacity = 0.8, color = ~pal_outcomes(health_outcomes),
group = "Health Outcomes", label = lapply(labs_outcomes, HTML)) %>%




  # Layers control

  addLayersControl(

    baseGroups = c("Health Index - Total", "Social Determinants", "Risk
Factors", "Health Outcomes"),

    overlayGroups = c("OSM (default)"),

    options = layersControlOptions(collapsed = FALSE)) %>%

  addLegend("bottomright", pal = pal_grand, values = utlas$grand_mean,
title = "Mean Z Scores for Index", opacity = 1)

# Download HALE data from GBD

temp <- tempfile()

download.file("http://s3.healthdata.org/gbd-api-2017-
public/e9890501faf9f59e13ea28802f789ac0_files/IHME-GBD_2017_DATA-e9890501-
1.zip", temp)

gbd_data <- read_csv(unz(temp, "IHME-GBD_2017_DATA-e9890501-1.csv"))

unlink(temp)

# Apply rank to HALE data

gbd_data$gbd_rank <- rank(gbd_data$val)

gbd_data$location[gbd_data$location == "St Helens"] <- "St. Helens"

# Create comparision data frame between GBD and CHI and test similaritiy
using Spearman's Rho

comparision <- left_join(utlas@data, gbd_data, by = c("ctyua17nm" =
"location"))
```

```
cor_test <- cor.test(~ overall.rank + gbd_rank, data = comparision, method
= "spearman", continuity = F, conf.level = 0.95)

# Create a summary stats data frame with all the components

summary_stats <- cbind(as.data.frame(soc_det_summary),
as.data.frame(risk_factors_summary),
as.data.frame(health_outcomes_summary))

names(summary_stats) <- substring(names(summary_stats), 2)


summary_stats <- as.data.frame(t(summary_stats))
```

Developing a Composite Health Index for England

Background

In 2018 the Chief Medical Officer called for the development of a Composite Health Index (CHI) to be developed in order to quantify health as a national asset and to track changes in health over time[^1].

Dahlgren & Whitehead's model suggests that health is determined by genetics, life stage, individual risk factors and behaviours, wider social determinants and the interaction between all of these[^2]. The variation in risk factors and social determinants is closely linked to deprivation, with the least deprived people having a life expectancy almost 10 years longer than the most deprived, and can expect almost 20 years more without living with a disability[^3]. Social determinants of health mutable with changes in policy within local and central government, growth of GDP, and changes in the distribution of wealth. Risk factors can be modified through policy and societal change. Health outcomes are a product of social determinants of health and individual risk factors' interaction with health services, and so health service performance should be included.

Tackling health inequalities requires understanding social determinants of health, risk behaviours, and health outcomes, and tracking change over time across the whole population.

Aims

This CHI will form a baseline measure of health from 2018 comprising of three component parts:

* Social determinants of health
* Individual risk factors and behaviours
* Health outcomes

The CHI will be presented by geographical area as to allow policy-makers to better understand the needs of their local populations and target interventions effectively.

Data Items

The CHI is based on academic theory as to the core components of health across the life course. Data items were selected to fulfill the definitions of social determinants, risk factors, and health outcomes defined in the Fair Society, Healthy Lives report (2010) (Table 1).

Table 1: Component parts of the determinants of health

Social Determinants	Risk Factors	Health Outcomes
Early years	Alcohol	Loss of years of life
Education	Smoking	Loss of years of healthy life
Work	Obesity	Economic costs
Income	Drug Use	
Communities		

Data items were selected from publicly available indicators that will be reproduced over time to satisfy the core components. This will allow benchmarking to current levels. A search was carried out using the terms in Table 1 on Public Health England's (PHE) Fingertips platform and indicators were selected from a variety of profiles to provide coverage. The selected indicators are shown in Appendix 1. Some indicators are replicated in more than one component as they are important to more than one component. For example, infant mortality is important to both early years and loss of years of life and so it is included in both social determinants and health outcomes components.

Added to the social determinants component were data from the Indices of Multiple Deprivation (IMD) subdomains. These subdomains are designed to quantify different forms of deprivation that impact people's lives in various ways. The subdomains are included as there is large geographic variation in performance across the subdomains that warrants extra granularity provided by the subdomain scores[^4]. For example, Wokingham has the lowest deprivation in the 'income' subdomain, but has high 'geographical barriers' deprivation.

Most recent data were used, however this was not consistent as to when it was produced as different indicators have differing reproduction schedules and timeframes. This could introduce some confounds into the analysis as we are not always comparing performance within the same temporal period. The alternative was to limit our analysis to indicators that are produced over the same period, however this would have led to omitting potentially valuable information. For example suicide rate is an important health outcome measure that has to produced over a three year period to not be disclosive.

Methods

Data items were retrieved using the FingertipsR package for PHE indicators, and using webscraping to retrieve IMD data. IMD data were segregated at Lower Super Output Area (LSOA) geographies, and so these were aggregated up to Upper Tier Local Authority (UTLA) using Office for National Statistics (ONS) lookup tables. Population weighted subdomain totals were used to calculate z-scores as a measure of geographical dispersion around the England mean.

Fingertips data were filtered to retrieve the most recent data points for each indicator, and also filtered to exclude any breakdowns by sex and limited to UTLAs. After this, UTLAs with over 50% missing data were excluded, which led to the removal of two areas; City of London and the Isles of Scilly. Indicators with more than 20% data missing were removed from the analysis as they are deemed to be incomplete.

Missing data from the remaining indicators were imputed using multiple imputation. Data are fit to 4 Bayesian generalized linear models over 30 iterations, and missing values predicted using these models, with the best fit being selected for imputation[^5]. Heatmaps of the spread of the data before and after imputation are shown in Figure 1.

Normality of distribution within each of the indicators was assumed using the Central Limit Theorem. Indicators were tested for covariance and indicators using a pairwise correlation matrix with those indicators with

an [] selected for removal, with the most globally correlated indicator being removed (Table 2).

Z-scores were calculated for all indicators, and mean z-scores and ranks calculated for components, polarity switched where necessary. These were then aggregated into the CHI giving equal weighting to each of the components. Summary statistics for each indicator were output as a baseline measure for future years.

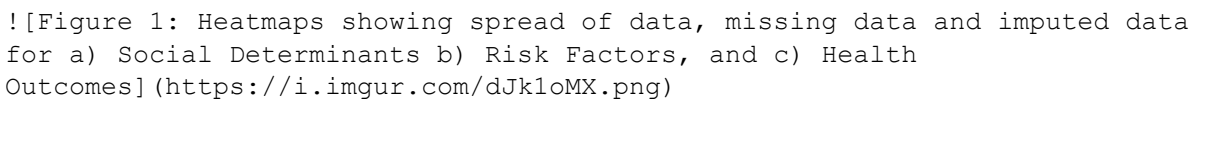


Table 2: Indicators from each component removed for covariance reasons

Social Determinants	Risk Factors	Health Outcomes
	Smoking attributable mortality CHD: Recorded prevalence (all ages)	Under 75 mortality rate from cardiovascular diseases considered preventable Under 75 mortality rate from cancer
		Under 75 mortality rate from cancer considered preventable
		Under 75 mortality rate from liver disease
		Under 75 mortality rate from respiratory disease
		Hip fractures in people aged 65 and over
		Mortality rate from causes considered preventable

Results

A CHI based on publicly available, national, long-term data was created based on three components; social determinants of health, individual risk factors, and health outcomes (Appendix 3). The contribution of individual indicators to each component was calculated, and each component was given equal weighing in the construction of the CHI. This index was mapped to UTLAs to give an overall view of the distribution of health across England (Figure 2).

```{r map, echo=FALSE, out.width = '100%'}
```

map1
```

Figure 2: The CHI total mapped to UTLAs in England. Lower Mean Z Scores indicator lower health in that geographical area.

There were a total of 79 Fingertips indicators and 16 IMD subdomains included after exclusions for missing data and collinearity (Appendix 2). It is possible to disaggregate the CHI into each component . It is also possible to analyse the contribution of each indicator to the index. The plotted outputs are designed to highlight the areas with greatest need.

Rankings were also produced for the CHI and its components, primarily as a tool to validate the index against other indices that use differing methodologies. Outputs of the top 5 ranked areas (most need) are shown in Table 3.

Table 3: CHI and component scores (ranks) for the 5 areas identified as having the greatest need.

| Area | CHI | Social Determinants Component | Risk Factors Component | Health Outcomes Component |
| --- | --- | --- | --- | --- |
| Blackpool | -1.132 (1) | -0.911 (2) | -0.959 (3) | -1.53 (1) |
| Kingston upon Hull | -1.079 (2) | -0.931 (1) | -1.055 (2) | -1.241 (2) |
| Knowsley | -0.885 (3) | -0.871 (3) | -0.757 (6) | -1.027 (5) |
| Middlesbrough | -0.873 (4) | -0.749 (7) | -0.764 (5) | -1.107 (3) |
| Hartlepool | -0.961 (5) | -0.511 (12) | -1.091 (1) | -0.961 (8) |

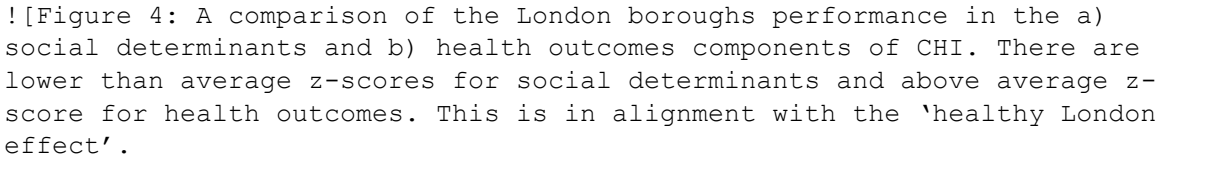
A comparative analysis were undertaken to verify the validity of CHI. Health Adjusted Life Expectancy (HALE) estimates, produced as part of the Global Burden of Disease study[^6], was selected as a comparator. Ranks were compared using a Spearman rank correlation test. There was a significant strong positive correlation between CHI and HALE.

```{r corr_, echo=FALSE}
cor_test
```
```

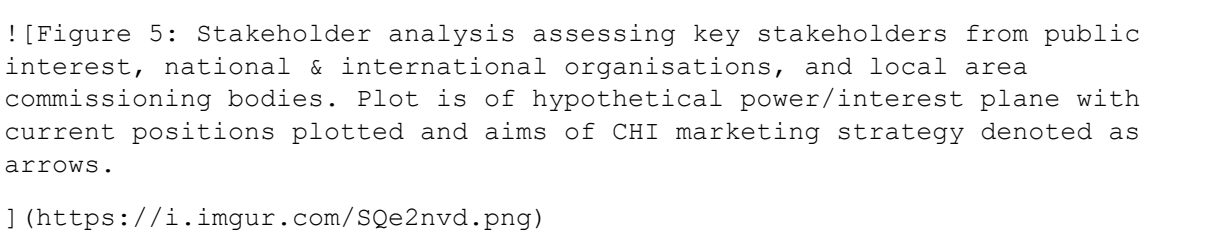
To track change over time, the means and standard deviations from this analysis are to be used in future z-score calculations to ensure the baseline stays stable. To this end, descriptive statistics were output for reference in future years (Appendix 3).

Discussion

A CHI was created to quantify, and track changes to, health across England. The outputs from this index appear to be in line with alternative measures of overall health, and also in line with previous literature on health inequalities. CHI shows a clear rural/urban divide that has been previously described[^7][^8]. There is also a north/south divide viewable if a line is drawn from the Bristol channel to the Wash, as has been previously described[^9][^10]. In addition to this, outputs from CHI may provide evidence for the 'healthy London effect', where London overperforms in health outcomes given the social determinants present (Figure 4)[^11].



CHI highlights previously described health inequality divides and strongly correlates with alternative measures. This suggests that CHI is a robust measure of health across England that can be used as a baseline measure for future reference and evaluation. Each indicator is given an equal weighting within the construct of each component, and each component has an equal weighting in CHI. There might an increase in accuracy with a more sophisticated weighting mechanism in future. There is also a risk of changes to the methods used in creating the indicators used in CHI, and this would have to be accounted for in future years. Effort should be made to replicate CHI at clinical geographies, such as Clinical Commissioning Groups, to allow more targeted policy action.



A brief stakeholder analysis was undertaken to assess the current power and interest of selected stakeholders (Figure 5)[^12]. The CHI is intended to give evidential support for interventions for those with position power to use, such as the CMO and public health organisations. Local commissioning will use CHI to target resources to reduce health inequalities. There is

the potential for media attention to develop a negative narrative around geographical variations (eg, “postcode lottery”). The intention would be to combat negative power using expert power from CMO and central government to control the media narrative.

Appendices

Appendix 1: Fingertips indicators selected to be included in analysis from Fingertips platform for each component before tests for missing data or covariance.

Social Determinants	Risk Factors	Health Outcomes
Population vaccination coverage - MMR for two doses (5 years old)	Fraction of mortality attributable to particulate air pollution	Sickness absence - the percentage of working days lost due to sickness absence
School readiness: Good level of development at age 5	Killed and seriously injured (KSI) casualties on the roads	Low birth weight of term babies: % of all live births
Gap in the employment rate between those with a long-term health condition and the overall employment rate	Smoking status at time of delivery	Infant mortality
Enough social contact in adult carers: % of adult carers	Child excess weight in 4-5 and 10-11 year olds - 4-5 year olds	Proportion of five year old children free from dental decay
Low birth weight of term babies: % of all live births	Child excess weight in 4-5 and 10-11 year olds - 10-11 year olds	Mortality rate from causes considered preventable
Breastfeeding prevalence at 6-8 weeks after birth	Proportion of the population meeting the recommended '5-a-day' on a 'usual day' (adults)	Under 75 mortality rate from all cardiovascular diseases
Smoking at time of delivery: % of mothers	Excess Weight in Adults	Under 75 mortality rate from cardiovascular diseases considered preventable
Under 18 conceptions	Physically active adults (aged 19+)	Under 75 mortality rate from cancer
Excess weight in Reception year: % of children aged 4-5	Smoking prevalence in adults (aged 18+)	Under 75 mortality rate from cancer considered preventable
Proportion of children aged 2-2½yrs offered ASQ-3 as part of the Healthy Child Programme or integrated review	Estimated diabetes diagnosis rate	Under 75 mortality rate from liver disease

| Hospital admissions caused by unintentional and deliberate injuries in children (aged 0-4 years) | Admission episodes for alcohol-related conditions | Under 75 mortality rate from liver disease considered preventable |

| Successful completion of drug treatment - opiate users: % who do not re-present within 6 months | Average number of portions of fruit consumed daily at age 15 (WAY survey) | Under 75 mortality rate from respiratory disease |

| Successful completion of drug treatment - non-opiate users: % who do not re-present within 6 months | Hypertension: Recorded prevalence (all ages) | Under 75 mortality rate from respiratory disease considered preventable |

| Successful completion of treatment for alcohol | Obesity: Recorded prevalence (aged 18+) | Mortality rate from a range of specified communicable diseases, including influenza |

| Self-reported well-being: % of people with a high anxiety score | Depression recorded prevalence (QOF): % of practice register aged 18+ | Suicide rate |

| Infant mortality | Stroke: Recorded prevalence (all ages) | Excess under 75 mortality rate in adults with serious mental illness |

| Long-term unemployment: rate per 1,000 working age population | CHD: Recorded prevalence (all ages) | Emergency readmissions within 30 days of discharge from hospital |

| STI testing rate (exc chlamydia aged <25) / 100,000 | Obese children (10-11 years) | Proportion of adults in the population in contact with secondary mental health services |

| HIV testing uptake, total (%) | Admission episodes for alcohol-specific conditions - Under 18s | Health related quality of life for older people |

| 16-18 year olds not in education, employment or training: % of 16-18 year olds | Smoking attributable mortality | Hip fractures in people aged 65 and over |

| Proportion of supported working age adults with learning disability living in unsettled accommodation (%) | Mortality rate from lung cancer | Preventable sight loss - age related macular degeneration (AMD) |

| Adults receiving long term learning disabilities support from local authority per 100 people on GP learning disabilities register | Under 75 mortality from colorectal cancer | Hip fractures in people aged 65 and over - aged 65-79 |

| People taking up an NHS Health Check invite | Under 75 Mortality rate from breast cancer | Preventable sight loss - glaucoma |

| Unemployment: % of working age population | Children killed and seriously injured (KSI) on England's roads | Hip fractures in people aged 65 and over - aged 80+ |

| Claimants of benefits due to alcoholism | Density of fast food outlets | Preventable sight loss - diabetic eye disease |

| Economic inactivity rate | | Excess winter deaths index (single year, all ages) |

| % reporting depression or anxiety | | Preventable sight loss - sight loss certifications |

| A&E attendances (0-4 years) | | Excess winter deaths index (single year, age 85+) |

| Hospital admissions caused by unintentional and deliberate injuries in children (aged 0-4 years) | | Excess winter deaths index (3 years, all ages) |

| Emergency admissions (aged 0-4) | | Excess winter deaths index (3 years, age 85+) |

| A&E attendances (0-4 years) | | 4.16 - Estimated dementia diagnosis rate (aged 65+) |

| Emergency admissions (aged 0-4) | | Healthy life expectancy at birth |

| Children with one or more decayed, missing or filled teeth | | Life Expectancy at birth |

| Percentage of children at or above expected level of development in all five areas of development at 2-2½ years | | Life expectancy at 65 |

| Percentage of children at or above expected level of development in communication skills at 2-2½ years | | Inequality in life expectancy at birth |

| Percentage of children at or above expected level of development in gross motor skills at 2-2½ years | | Number of UTLAs where inequality in life expectancy at birth has decreased |

| Percentage of children at or above expected level of development in fine motor skills at 2-2½ years | | Inequality in life expectancy at 65 |

| Percentage of children at or above expected level of development in problem solving skills at 2-2½ years | | Gap in life expectancy at birth between each local authority and England as a whole |

| Percentage of children at or above expected level of development in personal-social skills at 2-2½ years | | Inequality in healthy life expectancy at birth ENGLAND |

| Proportion of New Birth Visits (NBVs) completed within 14 days | | Inequality in healthy life expectancy at birth LA |

| Proportion of infants receiving a 6 to 8 week review | | Estimated prevalence of hypertension (all ages) - retired |

| Proportion of children receiving a 12-month review | | Estimated prevalence of CHD (all ages) - retired |

| Proportion of children who received a 2-2½ year review | | Estimated prevalence of stroke (all ages) - retired |

| Percentage of children achieving at least an expected level of development across all learning goals in communication and language. | | Estimated prevalence of CVD (all ages) - retired |

| Access to NHS dental services - successfully obtained a dental appointment | | Estimated prevalence of COPD (all ages) - retired |

| | | Estimated prevalence of diagnosed hypertension (16+) |

| | | Estimated prevalence of undiagnosed hypertension (16+) |

| | | Estimated prevalence of depression (all ages) |

| | | Estimated prevalence of CHD (55-79 yrs) |

| | | Estimated prevalence of CHD (55-79 yrs) |

| | | Estimated prevalence of stroke (55-79 yrs) |

| | | Estimated prevalence of peripheral arterial disease (PAD) (55-79 yrs) |

| | | Estimated prevalence of peripheral arterial disease (PAD) (55-79 yrs) |

| | | Estimated prevalence of Heart failure (16+) |

| | | Estimated prevalence of COPD (all ages) |

| | | Rate of deaths from Cardiovascular Disease among people aged 65 years and over |

| | | Rate of deaths from Cancer among people aged 65 years and over |

| | | Rate of deaths from Respiratory Disease among people aged 65 years and over |

Appendix 2: Final indicators included in the CHI from Fingertips and IMD in the components to which they contributed.

| Social Determinants | Risk Factors | Health Outcomes |

| --- | --- | --- |

| Population vaccination coverage - MMR for two doses (5 years old) | Fraction of annual all-cause adult mortality attributable to anthropogenic (human-made) particulate air pollution (measured as fine particulate matter, PM2.5*). | Low birth weight of term babies: % of all live births |

| School readiness: Good level of development at age 5 | Killed and seriously injured on roads | Under 75 mortality rate from all cardiovascular diseases |

| Gap in the employment rate between those with a long-term health condition and the overall employment rate | Child excess weight in 4-5 and 10-11 year olds - 4-5 year olds | Under 75 mortality rate from liver disease considered preventable |

| Enough social contact in adult carers: % of adult carers | Child excess weight in 4-5 and 10-11 year olds - 10-11 year olds | Under 75 mortality rate from respiratory disease considered preventable |

| Low birth weight of term babies: % of all live births | Proportion of the population meeting the recommended '5-a-day' on a 'usual day' (adults) | Suicide rate |

| Excess weight in Reception year: % of children aged 4-5 | Percentage of adults (aged 18+) classified as overweight or obese - current method | Emergency readmissions within 30 days of discharge from hospital |

| Proportion of children aged 2-2½yrs offered ASQ-3 as part of the Healthy Child Programme or integrated review | Physically active adults (aged 19+) | Preventable sight loss - age related macular degeneration (AMD) |

| Hospital admissions caused by unintentional and deliberate injuries in children (aged 0-4 years) | Smoking prevalence in adults (aged 18+) | Preventable sight loss - glaucoma |

| Successful completion of drug treatment - opiate users: % who do not re-present within 6 months | Estimated diabetes diagnosis rate | Preventable sight loss - sight loss certifications |

| Successful completion of drug treatment - non-opiate users: % who do not re-present within 6 months | Admission episodes for alcohol-related conditions | Hip fractures in people aged 65 and over - aged 65-79 |

| Successful completion of treatment for alcohol | Average number of portions of fruit consumed daily at age 15 (WAY survey) | Hip fractures in people aged 65 and over - aged 80+ |

| Self-reported well-being: % of people with a high anxiety score | Hypertension: Recorded prevalence (all ages) | Sickness absence - the percentage of working days lost due to sickness absence |

| Infant mortality | Obesity: Recorded prevalence (aged 18+) | Excess winter deaths index (single year, all ages) |

| Long-term unemployment: rate per 1,000 working age population | Depression recorded prevalence (QOF): % of practice register aged 18+ | Excess winter deaths index (single year, age 85+) |

| STI testing rate (exc chlamydia aged <25) / 100,000 | Stroke: Recorded prevalence (all ages) | Excess winter deaths index (3 years, all ages) |

| HIV testing uptake, total (%) | Admission episodes for alcohol-specific conditions - Under 18s | Excess winter deaths index (3 years, age 85+) |

| 16-18 year olds not in education, employment or training: % of 16-18 year olds | Deaths from lung cancer | Excess under 75 mortality rate in adults with serious mental illness |

| Proportion of supported working age adults with learning disability living in unsettled accommodation (%) | Under 75 mortality from colorectal cancer | Health related quality of life for older people |

| Adults receiving long term learning disabilities support from local authority per 100 people on GP learning disabilities register | Under 75 Mortality rate from breast cancer | Infant mortality |

| People taking up an NHS Health Check invite | Children killed and seriously injured (KSI) on England's roads | Mortality rate from a range of specified communicable diseases, including influenza |

| Unemployment: % of working age population | - | Proportion of adults in the population in contact with secondary mental health services |

| Claimants of benefits due to alcoholism | - | Proportion of five year old children free from dental decay |

| Economic inactivity rate | - | Rate of deaths from Cardiovascular Disease among people aged 65 years and over |

| % reporting depression or anxiety | - | Rate of deaths from Cancer among people aged 65 years and over |

| A&E attendances (0-4 years) | - | Rate of deaths from Respiratory Disease among people aged 65 years and over |

| Emergency admissions (aged 0-4) | - | Estimated dementia diagnosis rate (aged 65+) |

| Children with one or more decayed, missing or filled teeth | - | - |

| Proportion of New Birth Visits (NBVs) completed within 14 days | - | - |

| Proportion of infants receiving a 6 to 8 week review | - | - |

| Proportion of children receiving a 12-month review | - | - |

| Proportion of children who received a 2-2½ year review | - | - |

| Percentage of children achieving at least an expected level of development across all learning goals in communication and language. | - | - |

| Access to NHS dental services - successfully obtained a dental appointment | - | - |

| Income Score (rate) | - | - |

| Employment Score (rate) | - | - |

| Education, Skills and Training Score | - | - |

| Health Deprivation and Disability Score | - | - |

| Crime Score | - | - |

| Barriers to Housing and Services Score | - | - |

| Living Environment Score | - | - |

| Income Deprivation Affecting Children Index (IDACI) Score (rate) | - | - |

| Income Deprivation Affecting Older People (IDAOPI) Score (rate) | - | - |

| Children and Young People Sub-domain Score | - | - |

| Adult Skills Sub-domain Score | - | - |

| Geographical Barriers Sub-domain Score | - | - |

| Wider Barriers Sub-domain Score | - | - |

| Indoors Sub-domain Score | - | - |

| Outdoors Sub-domain Score | - | - |

Appendix 3: The CHI scores and rankings for UTLAs in England for 2018.

Candidate Number: ZVBZ7

AreaCode	Overall Score	Health Outcomes	Health Outcomes Rank	Overall Rank	Risk Factors	Risk Factors Rank	Social Determinants	Social Determinants Rank
E06000001	-0.85	-0.96	8	5	-1.09	1	-0.51	12
E06000002	-0.87	-1.11	3	4	-0.76	5	-0.75	7
E06000003	-0.36	-0.38	29	24	-0.45	19	-0.25	40
E06000004	-0.25	-0.28	39	41	-0.22	41	-0.24	44
E06000005	-0.21	-0.27	41	44	-0.23	40	-0.12	60
E06000006	-0.32	-0.35	31	29	-0.18	44	-0.42	20
E06000007	0.19	0.405	124	104	-0.05	69	0.218	104
E06000008	-0.41	-0.77	11	19	-0.17	46	-0.3	32
E06000009	-1.13	-1.53	1	1	-0.96	3	-0.91	2
E06000010	-1.08	-1.24	2	2	-1.05	2	-0.93	1
E06000011	0.15	0.055	73	98	0.074	85	0.322	120
E06000012	-0.32	0.036	70	28	-0.57	10	-0.44	16
E06000013	-0.1	0.091	77	56	-0.41	21	0.024	78
E06000014	0.15	0.306	111	97	-0.01	72	0.158	99
E06000015	-0.04	0.196	93	64	-0.15	51	-0.16	54
E06000016	-0.29	-0.62	15	34	0.166	101	-0.43	18
E06000017	0.48	0.772	145	138	0.229	106	0.439	131
E06000018	-0.53	-0.54	18	12	-0.45	18	-0.6	11
E06000019	0.099	0.184	90	86	0.01	78	0.102	88
E06000020	-0.11	-0.08	61	54	-0.08	65	-0.16	55
E06000021	-0.42	-0.44	24	18	-0.19	43	-0.63	9
E06000022	0.379	0.359	119	128	0.443	132	0.336	122
E06000023	0.077	0.148	87	82	0.365	124	-0.28	37
E06000024	0.326	0.327	114	121	0.367	125	0.285	114
E06000025	0.635	0.561	139	146	0.605	144	0.74	149
E06000026	-0.12	-0.09	60	51	-0.03	71	-0.25	43
E06000027	-0.4	-0.91	9	21	-0.1	63	-0.19	49
E06000028	-0.09	-0.19	52	60	-0.15	52	0.074	82
E06000029	0.266	0.229	98	116	0.112	90	0.456	133
E06000030	0.113	0.042	71	88	0.151	96	0.145	97
E06000031	-0.01	-0.19	50	68	0.246	109	-0.08	66

Candidate Number: ZVBZ7

E06000032	-0.11	0.022	67	52	-0.11	62	-0.25	42
E06000033	-0.03	-0.3	37	66	-0.06	67	0.278	113
E06000034	0.017	0.103	79	73	-0.27	36	0.219	105
E06000035	0	0.05	72	69	0.069	84	-0.12	59
E06000036	0.646	0.655	142	148	0.613	145	0.671	145
E06000037	0.558	0.64	141	142	0.323	117	0.712	148
E06000038	0.04	-0.19	51	77	0.248	110	0.061	80
E06000039	-0.1	-0.25	44	55	0.084	86	-0.14	57
E06000040	0.599	0.671	144	144	0.554	142	0.572	140
E06000041	0.748	0.519	134	149	0.757	147	0.968	150
E06000042	0.172	0.254	101	100	0.086	87	0.177	101
E06000043	0.067	-0.24	46	79	0.411	130	0.031	79
E06000044	-0.24	-0.34	33	42	-0.11	59	-0.27	39
E06000045	-0.38	-0.48	22	22	-0.34	27	-0.34	26
E06000046	-0.09	0.12	80	59	-0.36	24	-0.02	75
E06000047	-0.29	-0.55	17	35	-0.27	37	-0.05	71
E06000049	0.32	0.469	129	120	0.037	81	0.454	132
E06000050	0.221	0.205	94	110	0.101	88	0.356	125
E06000051	0.139	0.452	127	93	-0.15	50	0.115	90
E06000052	0.04	0.102	78	76	-0.11	61	0.126	93
E06000054	0.365	0.52	135	127	0.179	102	0.395	129
E06000055	0.097	-0.09	59	85	0.283	114	0.097	86
E06000056	0.463	0.659	143	136	0.129	93	0.601	141
E06000057	6.00E-04	0.026	68	71	-0.15	47	0.13	94
E08000001	-0.29	-0.4	26	36	-0.15	48	-0.31	30
E08000002	-0.15	-0.38	27	49	0.051	82	-0.11	61
E08000003	-0.77	-1.01	6	7	-0.45	17	-0.85	4
E08000004	-0.3	-0.15	55	33	-0.25	39	-0.48	13
E08000005	-0.47	-0.67	14	15	-0.13	54	-0.61	10
E08000006	-0.48	-0.7	13	14	-0.46	16	-0.28	38
E08000007	0.181	0.277	105	102	0.122	91	0.143	95
E08000008	-0.38	-0.43	25	23	-0.28	34	-0.43	19
E08000009	0.358	0.146	85	126	0.374	126	0.553	138
E08000010	-0.32	-0.58	16	27	-0.29	33	-0.1	63

Candidate Number: ZVBZ7

E08000011	-0.89	-1.03	5	3	-0.76	6	-0.87	3
E08000012	-0.78	-0.99	7	6	-0.59	9	-0.76	6
E08000013	-0.5	-0.53	20	13	-0.69	7	-0.28	36
E08000014	-0.32	-0.22	48	30	-0.35	26	-0.38	22
E08000015	-0.22	-0.3	36	43	-0.21	42	-0.16	53
E08000016	-0.53	-1.1	4	10	-0.49	14	-0.01	76
E08000017	-0.3	-0.29	38	31	-0.52	12	-0.08	65
E08000018	-0.35	-0.54	19	26	-0.4	22	-0.1	62
E08000019	-0.17	-0.06	63	47	-0.27	35	-0.18	50
E08000021	-0.4	-0.53	21	20	-0.36	25	-0.31	29
E08000022	-0.11	-0.04	64	53	-0.44	20	0.156	98
E08000023	-0.43	-0.46	23	16	-0.6	8	-0.23	46
E08000024	-0.63	-0.73	12	8	-0.78	4	-0.37	23
E08000025	-0.42	-0.38	28	17	-0.12	56	-0.76	5
E08000026	-0.26	-0.26	43	39	-0.15	49	-0.37	25
E08000027	-0.15	-0.24	47	48	-0.29	31	0.09	83
E08000028	-0.58	-0.81	10	9	-0.48	15	-0.45	15
E08000029	0.147	-0.02	65	95	0.232	107	0.224	108
E08000030	-0.3	-0.24	45	32	-0.32	28	-0.33	28
E08000031	-0.53	-0.37	30	11	-0.5	13	-0.73	8
E08000032	-0.25	-0.21	49	40	-0.18	45	-0.37	24
E08000033	-0.09	0.028	69	57	-0.31	30	0.009	77
E08000034	-0.17	-0.11	58	46	-0.12	58	-0.29	35
E08000035	-0.27	-0.31	34	38	-0.25	38	-0.24	45
E08000036	-0.35	-0.35	32	25	-0.39	23	-0.31	31
E08000037	-0.28	-0.28	40	37	-0.55	11	-0.02	74
E09000002	-0.19	-0.3	35	45	0	74	-0.25	41
E09000003	0.443	0.532	136	134	0.525	139	0.271	111
E09000004	0.283	0.356	117	117	0.204	104	0.288	116
E09000005	0.121	0.397	123	89	0.148	95	-0.18	51
E09000006	0.518	0.427	125	140	0.598	143	0.529	137
E09000007	0.413	0.846	148	129	0.48	134	-0.09	64
E09000008	4.00E-04	0.19	91	70	0.246	108	-0.43	17
E09000009	0.196	0.292	108	107	0.324	118	-0.03	73

Candidate Number: ZVBZ7

E09000010	0.121	0.392	120	90	0.359	121	-0.39	21
E09000011	-0.07	-0.12	57	62	0.122	92	-0.22	47
E09000012	-0.07	-0.07	62	61	0.152	97	-0.3	34
E09000013	0.071	0.068	74	80	0.289	115	-0.14	58
E09000014	0.095	0.192	92	84	0.397	128	-0.3	33
E09000015	0.461	0.555	137	135	0.54	140	0.287	115
E09000016	0.19	0.282	106	105	#####	76	0.29	117
E09000017	0.355	0.301	109	125	0.41	129	0.354	124
E09000018	0.142	-0.16	54	94	0.495	136	0.091	84
E09000019	-0.02	0.137	84	67	0.01	79	-0.22	48
E09000020	0.602	1.187	150	145	0.785	148	-0.17	52
E09000021	0.498	0.216	96	139	0.801	149	0.478	135
E09000022	0.126	0.129	82	91	0.331	119	-0.08	67
E09000023	0.128	0.15	88	92	0.138	94	0.096	85
E09000024	0.442	0.395	122	133	0.548	141	0.383	128
E09000025	0.004	0.084	76	72	0.257	111	-0.33	27
E09000026	0.243	0.322	112	112	0.342	120	0.064	81
E09000027	0.812	0.913	149	150	0.824	150	0.699	147
E09000028	0.154	0.206	95	99	0.291	116	-0.04	72
E09000029	0.345	0.217	97	124	0.45	133	0.368	127
E09000030	-0.04	-0.18	53	63	0.508	137	-0.46	14
E09000031	0.022	-0.13	56	74	0.274	112	-0.08	69
E09000032	0.427	0.357	118	131	0.633	146	0.29	118
E09000033	0.329	0.778	146	122	0.365	123	-0.15	56
E10000002	0.581	0.557	138	143	0.509	138	0.679	146
E10000003	0.433	0.467	128	132	0.36	122	0.472	134
E10000006	-0.09	0.133	83	58	-0.32	29	-0.08	68
E10000007	0.032	0.075	75	75	-0.12	57	0.143	96
E10000008	0.214	0.247	99	109	0.157	98	0.239	109
E10000009	0.256	0.254	102	114	0.03	80	0.482	136
E10000011	0.08	0.26	103	83	-0.13	55	0.112	89
E10000012	0.178	0.275	104	101	0	75	0.261	110
E10000013	0.293	0.518	133	119	0.165	100	0.194	102
E10000014	0.424	0.471	130	130	0.18	103	0.62	143

E10000015	0.473	0.474	131	137	0.377	127	0.57	139
E10000016	0.149	0.248	100	96	-0.01	73	0.208	103
E10000017	-0.15	-0.26	42	50	-0.29	32	0.118	91
E10000018	0.335	0.326	113	123	0.281	113	0.397	130
E10000019	-0.04	0.01	66	65	-0.06	68	-0.07	70
E10000020	0.193	0.445	126	106	0.008	77	0.125	92
E10000021	0.11	0.171	89	87	-0.06	66	0.219	106
E10000023	0.238	0.485	132	111	-0.14	53	0.365	126
E10000024	0.066	0.147	86	78	-0.05	70	0.1	87
E10000025	0.644	0.782	147	147	0.483	135	0.669	144
E10000027	0.206	0.287	107	108	0.056	83	0.276	112
E10000028	0.076	0.121	81	81	-0.11	60	0.221	107
E10000029	0.261	0.394	121	115	0.219	105	0.17	100
E10000030	0.554	0.622	140	141	0.428	131	0.612	142
E10000031	0.187	0.352	116	103	-0.1	64	0.312	119
E10000032	0.288	0.351	115	118	0.161	99	0.351	123
E10000034	0.245	0.302	110	113	0.107	89	0.325	121

Appendix 4: Baseline measurements of component parts of CHI for future evaluation against.

Indicator	Stand dev	Mean	Median	Coefficient of Variation	Minimum	Maximum
X10501	1.353	4.218	4.05	0.321	1.48	7.911
X20101	0.64	2.845	2.77	0.225	1.57	5.3
X20601	2.886	22.52	22.59	0.128	13.92	29.62
X22304	2.749	20.39	20.47	0.135	13.94	30.47
X30311	6.5	87.02	88.91	0.075	66.66	95.77
X90244	1.983	6.806	6.695	0.291	1.99	13.42
X90245	8.34	35.91	35.75	0.232	16.92	60.47
X90282	3.639	11.98	11.8	0.304	0.2	21.8
X90631	3.184	71.47	71.33	0.045	63.86	80.5
X90638	6.801	34.67	34.4	0.196	21.5	55
X90809	276.7	659.2	588.7	0.42	321.3	2011

Candidate Number: ZVBZ7

X90820	7.702	24.74	22.99	0.311	10.4	47.1
X90832	41.63	124.8	117.9	0.334	51.49	272.6
X91116	11.22	48.41	47.74	0.232	17	100
X91126	1.475	4.675	4.55	0.316	1.7	10.3
X91133	2.61	3.852	3.333	0.678	0.714	13.3
X91307	9971	17441	13983	0.572	8021	59480
X91463	77.34	143.5	125.1	0.539	38.52	575.2
X91524	11.63	75.98	79.34	0.153	30.48	91.94
X92196	1.167	3.826	3.59	0.305	1.742	8.053
X92447	8.075	39.13	39.62	0.206	18.16	54.89
X92477	55.55	162.4	161.9	0.342	56.94	297.3
X92543	9.696	91.06	93.7	0.106	56.9	102.4
X92785	2.296	94.46	94.8	0.024	86.3	98.8
X92899	4.157	22.24	21.45	0.187	13.3	33.9
X93131	8.061	19.39	19.52	0.416	1.29	36.21
X93175	11	56.75	55.84	0.194	32.03	100.2
X93376	2.455	14.06	13.89	0.175	8.974	19.85
X93469	9.129	87.87	90.07	0.104	33.15	98.95
X93470	14.92	84.98	89.01	0.176	14.09	112.7
X93471	15.86	84.04	88.63	0.189	9.955	99.78
X93472	16.42	77.39	80.47	0.212	0.939	101.1
X93494	3.278	82.27	82.4	0.04	74.31	94.8
X212	0.49	1.731	1.777	0.283	0.719	2.674
X219	2.364	13.83	14	0.171	7.482	18.04
X848	2.099	9.835	9.747	0.213	5.375	15.57
X1203	15.6	60.03	58.64	0.26	33.52	106.6
X11001	11.76	37.94	36.19	0.31	16.99	79.62
X20601	2.887	22.52	22.59	0.128	13.92	29.62
X20602	4.367	34.81	34.67	0.125	21.71	44.5
X30101	1.026	5.092	5.023	0.202	3.109	7.029
X90804	7.974	17.11	15.69	0.466	2.584	41.66
X91163	1.937	12.16	12.05	0.159	7.38	16.78
X91164	1.356	10.6	10.48	0.128	6.711	15.23
X91414	139.1	651.4	637.4	0.214	393.8	1097

Candidate Number: ZVBZ7

X92443	2.971	15.16	14.94	0.196	8.131	23.07
X92527	0.207	2.415	2.385	0.086	2.01	3.26
X92588	2.365	9.9	9.884	0.239	4.198	15.28
X92904	17.85	34.95	32.72	0.511	6.754	106.5
X93014	5.005	65.25	65.8	0.077	53.34	78.02
X93077	4.779	56.94	56.91	0.084	45.73	68.76
X93088	5.865	61.61	62.19	0.095	40.47	74.95
X93347	8.023	77.08	78.24	0.104	54.31	97.46
X20101	0.64	2.845	2.77	0.225	1.57	5.3
X40401	17.51	77.34	75.57	0.226	43.98	133.4
X40602	5.441	17.71	16.68	0.307	9.513	43.03
X40702	7.795	20.66	19.65	0.377	7.48	46.4
X41001	2.156	9.879	9.492	0.218	6.054	17.93
X41101	1.067	11.85	11.91	0.09	8.81	14.53
X41201	42.65	108.7	107.6	0.392	11.69	299.9
X41202	7.628	13.82	12.43	0.552	-1.96	70.29
X41204	15.77	41.61	40.57	0.379	6.318	130
X41402	43.5	252.1	245.2	0.173	157.5	382.3
X41403	224.7	1526	1533	0.147	934.4	2404
X90287	0.355	1.154	1.126	0.308	0.394	2.488
X90360	7.403	21.34	21.33	0.347	-2.78	42.41
X90361	10.27	30.8	30.17	0.333	5.325	72.16
X90641	4.069	20.74	20.71	0.196	4.348	34.38
X90642	5.847	29.45	29.36	0.199	11.11	44.46
X91096	77.92	374.7	366.8	0.208	164.8	570.4
X91195	0.03	0.73	0.733	0.041	0.634	0.793
X92196	1.167	3.826	3.59	0.305	1.742	8.053
X92326	3.284	11.54	11.26	0.285	5.345	20.61
X92327	1.848	5.383	5.053	0.343	2.682	14.5
X92441	7.677	75.07	76.51	0.102	52.9	93.59
X92718	132.8	1137	1135	0.117	767.3	1550
X92724	127.6	1126	1121	0.113	834.6	1473
X92725	123.7	663	642.3	0.187	412.4	973.9
X92949	7.331	69.35	68.75	0.106	52.5	90.2

<!-- Footnotes themselves at the bottom. -->

References

[^1]:

Chief Medical Officer annual report 2018: better health within ... - Gov.uk. Retrieved April 18, 2019, from https://www.gov.uk/government/publications/chief-medical-officer-annual-report-2018-better-health-within-reach

[^2]:

Dahlgren G, Whitehead M. 1991. Policies and Strategies to Promote Social Equity in Health. Stockholm, Sweden: Institute for Futures Studies.

[^3]:

Marmot, M. (2010). Fair Society Healthy Lives full report - Parliament.uk. Retrieved April 18, 2019, from https://www.parliament.uk/documents/fair-society-healthy-lives-full-report.pdf

[^4]:

Senior, S., (2019). Hierarchical clustering of English local authorities by sub-domains of the English Indices of Multiple Deprivation. Presented at Public Health England Scientific Conference 2019, University of Manchester.

[^5]:

Su, Y. S., Gelman, A., Hill, J., Yajima, M., 2011. Multiple Imputation with Diagnostics (mi) in R - Columbia Statistics. Retrieved April 18, 2019, from http://www.stat.columbia.edu/~gelman/research/published/mipaper.pdf

[^6]:

Institute for Health Metrics and Evaluation (IHME). GBD Compare. Seattle, WA: IHME, University of Washington, 2015. Available from http://vizhub.healthdata.org/gbd-compare.

[^7]:

Connolly S, O'Reilly D, Rosato M., 2007. Increasing inequalities in health: is it an artefact caused by the selective movement of people? _Social Science & Medicine. _2007;64(10):2008–2015.

[^8]:

Riva, M., Curtis, S., Gauvin, L., Fagg, J., 2009. Unravelling the extent of inequalities in health across urban and rural areas: Evidence from a national sample in England. _Social Science & Medicine, _68;4, 654-663.

[^9]:

Doran, T., Whitehead, M., 2004. Is there a north-south divide in social class inequalities in health in Great Britain? Cross sectional study using data from the 2001 census. _BMJ_ 2004; 328 doi: https://doi.org/10.1136/bmj.328.7447.1043

[^10]:

Kontonpantelis, E., Buchan, I., Webb, R. T., Ashcroft, D. M., Mamas, M. A., Doran, T., (2018). Disparities in mortality among 25–44-year-olds in England:

a longitudinal, population-based study. _Lancet Public Health. _3: e567-75

[^11]:

Minton, J.W., McCartney, G., 2018. Is there a north-south mortality divide in England or is London the outlier? _Lancet Public Health, _3:12, PE556-E557

[^12]:

Buse, K., Mays, N, Walt G., (2012). Making Health Policy. McGraw-Hill Education (UK).