RESOURCE ALLOCATION FOR LOCAL PUBLIC HEALTH

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CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

PURPOSE OF THE REPORT

BACKGROUND

Many of the responsibilities for improving the public's health and reducing health inequalities were transferred from the NHS to Local Authorities under the Health & Social Care Act 2012. Each Local Authority has been given a dedicated grant since April 2013 to fund these new public health responsibilities. The current basis on which allocations are made is regarded as provisional and a more evidence-based approach is required.

The need for a public health formula that has a firmer evidence-base has been explicitly stated in policy documents. Allocation of a separate grant for public health to Local Authorities raises the profile of this element of the formula and justifies it being given further attention.

There is considerable potential to develop the data and methods that underpin the resource allocation formulae for public health services. Many public health services funded by Local Authorities are delivered to individuals and the budgets for these can be most sensitively allocated on the basis of an utilisation model, using the latest micro data and estimation methods.

For the remaining population-level interventions, a formula is required that avoids perverse incentives. These can arise if Local Authorities that improve the health of their population and reduce health inequalities receive lower future allocations. New incentives for local communities to reduce inequalities and improve health were introduced in 2015/16. This Health Premium Incentive Scheme concentrates on measures in the Public Health Outcomes Framework. Options for a formula based on the underlying drivers of need rather than actual achieved levels of population heath are required.

In addition, Local Authorities are just one of the organisations required to provide public health functions. Some public heath functions are the responsibility of NHS England, including immunisation programmes, screening programmes, cancer screening programmes, children's public health services, child health information systems, public health care for people in prison and other places of detention, and sexual assault services. Public Health England is tasked with advising public bodies, supporting the public, providing the national health protection service, collecting data and reporting on the public’s health, and developing the public health system and its specialist workforce. In addition, NHS organisations retain a responsibility for improving health and reducing inequalities. A formula is required that takes account of the multiplicity of influences on public health needs and the interactions between the organisations tasked with improving the public’s health and reducing inequalities.

AIMS, OBJECTIVES, AND SCOPE

The aim of this research is to support the Advisory Committee on Resource Allocation (ACRA) and its Technical Advisory Group (TAG) in developing an evidence-based, equitable formula for distributing public health funds to Local Authorities. The research will provide a formula based on the data currently available for short-term allocations and will review methodologies for improving this formula in the longer term.

The objectives of the research are to:

- recommend options to ACRA for an evidence-based public health formula, building on the work already undertaken by ACRA and TAG and adding further evidence to improve the formula.
- estimate a formula based on the cost of meeting the relative need for public health services, supporting reductions in health inequalities and accounting for health inequalities within as well as between local authorities.

The research uses large national datasets to estimate relative population needs for public health services and interventions in each Local Authority. The research covers public health grants to Local Authorities only, and does not address the other public health funding streams. The research covers relative needs only and does not include re-estimation of the adjustment for input prices (the Market Forces Factor), which is outside the scope of this work. The research also does not cover the Health Premium Incentive Scheme (HPIS), but should be seen as complementary to it.

We estimate utilisation models for public health services that are delivered to individuals and for which individual or small-area data on utilisation are available. These include services for sexual health, and for drugs and alcohol misuse. For the allocation of funds for population-level services, we use multivariate regression techniques to estimate expected levels of population health based on population characteristics that are outwith Local Authority control.

The research has been reported to the independent Advisory Committee on Resource Allocation, who advise the Secretary of State on the funding formula. The research is intended to inform the allocations from 2016/17 onwards.

Recommendations for longer-term development of the funding formula will be based on a review of possible methodologies and a comparison of ideal and available datasets and information. These recommendations will form an additional report in September 2015.

STRUCTURE OF THE REPORT AND AUTHOR CONTRIBUTIONS

The report contains a review of the existing formula for public health budgets, and sets out the potential areas for improvement in the formula. The report comprises three separate sets of formulae: i) population health; ii) drugs and alcohol misuse; and iii) sexual health. Each component works as a standalone chapter and concludes with recommended models for implementation for the 2016/17 allocations.

The research was undertaken by a team at the University of Manchester. The research was led by Professor Matt Sutton and the research team includes experts in drugs misuse, health economics, national datasets, and statistical modelling. Particular contributions and respective contact details are contained in Table 1.

TABLE 1 AUTHOR CONTRIBUTIONS AND CONTACT DETAILS

Contribution	Author	
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OVERVIEW OF THE EXISTING FUNDING FORMULA

The Department of Health (DH) technical guide for public health allocations (Department of Health, 2012) sets out the formula applied to generate target and actual Local Authority (LA) allocations for 2013-14 and 2014-15. The public health allocation formula was led by the Advisory Committee on Resource Allocation and was the first allocation formula for public health.

The current formula consists of three separate groups of services: mandated services; non-mandated services; and substance misuse services. For each there is an SMR<75 weighted population. There are six sets of age-gender weights used to generate age-gender indices for mandated and non-mandated services.

Needs-weighted (SMR<75) populations

Need is captured by weights based on standardised mortality ratios (SMR<75) for each MSOA and scaled up to LA level. Weights are exponentially applied at a ratio of 5:1 to target those areas with poorer outcomes. MSOA-level SMRs were chosen to capture inequalities in health within as well as between LAs.

The MSOA-level population figures were obtained via 2010 mid-year estimates derived by the ONS from the 2001 Census. These were uplifted to LA-level estimates derived by ONS from the 2011 Census. MSOA population estimates were not based on 2011 Census data because the measure of SMR was derived from data prior to 2011.

The SMR (all causes) was generated from 2006-2010 Public Health Observatory data. It is used as a measure for the health of the whole population. SMR was chosen over Disability Free Life Expectancy and Healthy Life Expectancy due to the updatability of SMR and high correlations between the measures.

Each MSOA is split into one of ten groups based on their SMR. Each group covers at least 5% of MSOAs, and covers the same span of SMR<75 values ('equal-width' – 12.4). The weights for each group range from 1 to 5. Multiplying the MSOA population by the needs/SMR<75-weight and normalising creates the weighted population at MSOA level. MSOAs are then mapped into LAs.

Age-gender adjustments

For services targeted at specific age-gender groups, additional age-gender adjustments are applied. The data used to generate the weights for each age-gender group are taken from: the 2010 Health Survey for England (HSE); diagnosis rates for sexually-transmitted infections (STIs) from the Health Protection Agency (HPA) 2010; and drug treatment activity from the National Treatment Agency (NTA – now part of Public Health England) 2010-11.

The six sets of age-gender weights are:

- Nutrition, obesity and physical activity - percentage eating fewer than five a day (HSE) (for populations aged 5 years and over); average of parental age groups (for the under fives)
- Sexual health – diagnosis rates from GUM clinics for gonorrhoea, syphilis, herpes (1st episode), warts (1st episode) per 100,000; chlamydia diagnosis at GUM and community (HPA) (16+ years)

- Alcohol misuse – percentage aged 16+ who binge drink (HSE); % 14/15 year olds having an alcohol drink in last 4 weeks (HSE) (5-15 years); average of parental age groups (under 5s)
- Tobacco misuse – percentage aged 16+ who smoke (HSE); % 14/15 year olds who have either smoked last week, smoked sometimes, or who are often near people who smoke (HSE) (5-15 years); average of parental age groups (under 5s)
- Children's 5-19 services – weight of 1 for each population member aged 5-19
- Drug misuse – activity data for all drug misuse (NTA) as % age-gender population (12+ years); average of parental age groups (under 12s)

These weights are applied to ONS populations, combined using 2010-11 spend, converted to age-gender indices, and applied to the SMR<75 weighted population.

Substance misuse services

A separate weighted population is generated for substance misuse services. This covers three areas: drugs previously funded through the pooled treatment budget (PTB), all other drug services, and alcohol misuse services. The drugs services previously provided by PTB have three components, activity (76% in 2014-15), need or SMR<75 (24%), and performance (20% in 2013-14, 0% thereafter).

The activity figures are obtained from Drug Partnership Teams and covers Opiate and Crack users (OCU) and non-OCUs, reflecting the fact that OCUs cost twice as much as non-OCUs. An activity-weighted population is derived from the sum of OCU activity/users + (non-OCU activity/user)/2 multiplied with the MFF. For all other drugs, the same needs-approach is used as for mandated services using the SMR<75.

Overall formula

The overall weighted population is based on relative spend in 2010-11 (mandated – 28%, non-mandated – 38%, and substance misuse – 34%). Within substance misuse services, the weights are 51% for drugs services previously funded by PTB, 30% for non-PTB services, and 18% for alcohol services.

The formula also follows the CCG formulae with a Market Forces Factor (MFF) to generate target allocations, and a Pace of Change (PoC) factor to determine actual allocations.

Local Authority expenditure on public health

The General Fund Revenue Accounts Expenditure 2013-14[1] contains a breakdown of Local Authority expenditure (Table 2). Total spend is taken from the sum of activities 361-385. This amounts to £2.5bn. There are three areas for which we estimate separate weights: population-level interventions; drugs and alcohol services provided to individuals; and sexual health services provided to individuals.

[1] https://www.gov.uk/government/statistics/local-authority-revenue-expenditure-and-financing-england-2013-to-2014-individual-local-authority-data

Expenditure on sexual health services to individuals (activities 361 and 362) amounts to £561million (22.3% of total expenditure on public health). Expenditure on drug and alcohol services to individuals (activities 367, 368 and 369) amounts to £794million (31.5% of total expenditure).

OVERVIEW OF PROPOSED APPROACH

Funding formulae have been used since the 1970s to distribute resources for health improvement and provision of health care services to local organisations. Carr-Hill et al (1994) pioneered the development of utilisation-based models for resource allocation. Sutton et al's (2002) development of this methodology introduced regional-level dummy variables to control for differences in supply and non-need variables to control for differentially-met need (dubbed 'unmet need'). Morris et al's (2008) refinement of this methodology offered one-stage stratified models, which allowed the effects of additional need variables to vary flexibly across age categories and for the effects of age to be estimated conditional on variations in supply. Most recently, Dixon et al (2010) developed a person-based allocation methodology for acute hospital services, which Sutton et al (2012) reproduced for mental health services. Person-based allocation is now the preferred methodology where the data are available, with aggregate-level modelling being maintained only where the data do not permit a person-based approach (e.g. GP prescribing).

The first stage of the project involved collating up-to-date statistics for small geographical areas on population health, cost-weighted utilisation for public health services provided to individuals, a wide range of potential additional needs variables, supply variables and resident populations.

We used the latest Mid-Year Estimates of populations from the ONS by age, sex and LSOA. For the additional need variables we reviewed the datasets that were available, with a preference for variables that were readily available and updateable and a requirement that the variables were statistically robust and available for the whole of England. The principal data sources were ONS vital statistics (deaths and births), 2011 Census, Index of Multiple Deprivation and Neighbourhood Statistics. We sourced supply variables from the utilisation datasets and other administrative sources.

A utilisation-based methodology is adopted for allocations to Clinical Commissioning Groups for health services. This methodology is likely to be appropriate for the public health functions which are based on delivery of services to individuals and for which data on activity at individual or small-area level are available. These include drugs and alcohol misuse and sexual health services, which together account for approximately half of the expenditure by Local Authorities on their public health responsibilities.

TABLE 2 BREAKDOWN OF THE GENERAL FUND REVENUE ACCOUNTS EXPENDITURE 2013-14

Public Health service	Net current expenditure (£'000)	Coverage of the formulae
363 Sexual health services - Advice prevention and promotion (non-prescribed functions)	83,955	Population Health
365 NHS health check programme (prescribed functions)	56,376	
366 Health protection - Local authority role in health protection (prescribed functions)	34,025	
368 National child measurement programme (prescribed functions)	23,613	
370 Public health advice (prescribed functions)	64,287	
371 Obesity - adults	59,293	
372 Obesity - children	29,188	
373 Physical activity - adults	48,622	
374 Physical activity - children	22,871	
380 Smoking and tobacco - Stop smoking services and interventions	128,083	
381 Smoking and tobacco - Wider tobacco control	18,868	
383 Children 5–19 public health programmes	241,632	
385 Miscellaneous public health services	346,296	
376 Substance misuse - Drug misuse - adults	532,677	Drugs and alcohol
377 Substance misuse - Alcohol misuse - adults	190,081	
378 Substance misuse - (drugs and alcohol) - youth services	70,848	
361 Sexual health services - STI testing and treatment (prescribed functions)	382,455	Sexual health
362 Sexual health services - Contraception (prescribed functions)	178,679	
390 Total (total of lines 361 to 385)	2,511,844	

For population-level interventions, we modelled the underlying determinants of the SMR<75 to generate predicted levels of population health based on factors (largely) outwith Local Authority influence. These underlying determinants included measures of poverty and deprivation. Allocation of resources on the basis of a predicted SMR<75 could mitigate concerns over perverse incentives compared with the use of actual SMR<75. We used a conceptual model of the links between population health, population characteristics and policy variables. The policy variables include measures of input to health by Local Authorities and by NHS and other State organisations. These are treated like supply variables in utilisation models, as variables that influence the outcome, may be correlated with needs variables, and should therefore be included in the estimation model but not in the allocation equation.

We developed an econometric methodology to estimate the effects of age and additional need variables on need for public health care services. For the utilisation models, we explored three different modelling options that have been considered in previous formula review work:

1. Age-standardised models: predictors of small-area variation in actual/expected cost ratios based on age/gender standardisation. This was the approach used in reviews prior to the CARAN review.
2. Age-stratified models: predictors of small-area variation in actual/expected cost ratios for different age groups (e.g. less than or greater than 18 years) and genders. This approach was taken in the CARAN review and for mental health services in the RAMP (Sutton et al, 2010) review.
3. Person-based models: predictors of costs at individual level using supply-independent risk markers (e.g. arrest referral) in previous years to predict costs in the current year. This approach was used for mental health services in the PRAM (Sutton et al, 2012) review.

These methodologies were applied to data on drugs and alcohol misuse services and sexual health services and their robustness and their distributional consequences were compared. As in previous work, we used Dummy-Variable Ordinary Least Squares regression with standard errors robust to heteroskedasticity. The aggregate analyses were weighted by the denominators of the dependent variable. Specification tests were used to investigate omitted variables and functional form.

In previous work (Dixon et al, 2010; Sutton et al, 2012), we have developed and applied a wide range of statistical measures and criteria for variable and model selection. We followed the same approach for the modelling in this project. The number of additional need variables selected is a trade-off between parsimony and goodness-of-fit. We provide models that represent different trade-offs between parsimony and goodness-of-fit and calculate the cost, in terms of lost goodness-of-fit and misallocation between Local Authorities, of the more parsimonious models.

Together, these developments of resource allocation for local public health address several of the weaknesses already identified by ACRA in the existing formula, that:

- the SMR<75 may not be a stable measure of need
- the formula should be linked to a measure of deprivation, not a health outcome
- the SMR<75 may not be strongly linked to needs for sexual health services, and
- the underlying need component of the current formula for substance misuse services was developed in 2000 and is now difficult to update.

ALLOCATING RESOURCES FOR PREVENTION ACTIVITY

The public health budget for Local Authorities is devoted to both prevention and treatment activity. There is a widely-held view that a greater proportion of the budget should be spent on prevention.

Data are not available either at an individual or small-area level on prevention expenditure. Our empirical analysis therefore focuses on treatment activity for sexual health and addiction services. There is a perception that this focus under-estimates the importance of prevention and risks conveying a message that expenditure on prevention should not be increased.

It is important to note that the expenditure shares used to weight the various formulae to arrive at the total public health formula are not intended to drive local expenditure patterns. Local Authorities have discretion about how to prioritise their spending within their overall allocated budget.

It is also important to note that budgets are allocated on risk factors that predict levels of expenditure, not actual levels of expenditure. Therefore, Local Authorities that undertake a substantial amount of successful prevention activity, and consequently reduce their expenditure on treatment services, are not penalised by the formula. Local Authorities are allocated resources on the basis of their expected spend not their actual spend.

The third element of our formula work is on population health. In this component, we are modelling the Standardised Mortality Ratio, under 75 years. It is expected that this formula will be used for all general and preventive expenditure. The rationale is that higher levels of premature mortality are indicative of a higher need for prevention and other population health improvement activity. For a variety of reasons (including statistical stability, avoiding perverse incentives, ensuring that successful historical health improvement activity is not penalised), we are examining whether it is possible to produce a modelled SMR, based on population characteristics that are outside the control of Local Authorities.

The problem with this approach is that there may be health problems that are preventable and are not life-threatening or life-limiting, and whose distribution is not proportional to the SMR<75. Examples may be sexual health and addiction.

For prevention activity concerning sexual health and addiction, there are a number of approaches that may be adopted:

1. Assume that need for prevention is equal per capita and allocate these funds on an unadjusted per capita basis
2. Assume that need for prevention follows the distribution of the SMR<75 and allocate these funds on the basis of the population health formula
3. Assume that need for prevention follows the distribution of the need for treatment services and allocate these funds on the basis of the sexual health or addiction treatment services formulae.

The age distribution of sexual health and addiction problems suggests that need for prevention is neither equal on a per capita basis nor proportional to the SMR<75. Neither approach (1) nor (2) therefore seem appropriate. We might therefore consider approach (3) to be most appropriate, if the risk factors that predict treatment need are similar to those that predict prevention need. For example, sexual health problems reach their peak in the population in their 20s. This demographic group are therefore likely to be in more need of prevention than older population groups.

Prevention expenditure may reduce the level of expenditure on treatment services. If this effect is proportional (i.e. prevention expenditure reduces the overall level of treatment services spend but not its distribution across the identified risk factors), then there is no bias generated by the failure to consider or model prevention activity explicitly.

However, there is an issue if prevention activity changes the distribution of treatment services expenditure across the risk factors. For example, consider a prevention activity that is implemented across the country and reduces to zero the level of treatment services expenditure in a particular population group. In the treatment modelling exercise, this population group would be identified as having zero need for treatment services. If this same formula is used to allocate prevention expenditure, the needs of this group for prevention expenditure is not recognised and the formula is biased against this group. This bias is reduced if the implementation is partial and/or the effect on treatment expenditure is not to completely eradicate it, but a partial bias still exists. Prevention activity may influence the relationship between risk factors and treatment expenditure, and allocation of the total prevention and treatment budget on the basis of how risk factors predict treatment expenditure may therefore be biased.

Is it possible to identify whether prevention activity influences the relationships between risk factors and treatment expenditure? There are no data at individual or small-area level on prevention expenditure. But, expenditure returns by Local Authorities do indicate which Local Authorities spend more or less on prevention activity. We can therefore split Local Authorities into three groups (low prevention spend, average prevention spend, high prevention spend) and estimate the treatment expenditure equation separately for these groups.

This is the approach we take in this report. If we find that the coefficients (or weightings) on the risk factors depend systematically on the Local Authority level of prevention spend, then this is evidence that variations in prevention spend may be leading to bias in the treatment need equation. If we find that the coefficients on the needs variables are independent of the level of LA prevention spend, this would suggest that the estimated effects of risk factors on treatment spend are independent of the level of prevention activity. This would imply that prevention activity is either ineffective in reducing treatment spend in the short–term, or that its effects are proportional across risk factors, i.e. prevention reduces treatment expenditure but equally across all risk groups. In this case, it would be appropriate to use the treatment need equation to allocate all expenditure, including prevention activity.

POPULATION HEALTH SERVICES FORMULA

This chapter discusses the data sources, estimation methods, and tracks the overall development of models of variations in Medium-Layer Super Output Area (MSOA) rates of excess mortality.

DEVELOPMENT OF A FORMULA FOR POPULATION HEALTH SERVICES

We have developed models of the excess death rate for the population aged 75 years and under at the MSOA level for the years 2008-2012. This model is based on a set of variables included to capture influences that are known to impact geographical variations in the rate of excess mortality (Inquiry Panel on Health Equity for the North of England, 2014). These originally included need and supply influences; such as income deprivation as measured in the 2010 IMD Indices of Deprivation, the rate of air pollution (Janke et al, 2009) and the number of general practitioners (GPs) per capita. The latter was removed, as it had no statistically significant effect on the excess mortality rate. Further development of the original model was based on both feedback from the Advisory Committee on Resource Allocation and Technical Advisory Group, and considerations of the statistical efficiency of the model. We describe the model and track its development in this following sections.

OUTLINE OF DATA, METHODS AND MODEL DEVELOPMENT

We use data on the rate of excess mortality at MSOA level for the years 2008-2012 provided by NHS England.

We also present models using various MSOA-level measures for self-assessed health from the 2011 Census. The various definitions were generated using the five categories for self-assessed health which respondents to the census can self-report:

- very good;
- good;
- fair;
- bad;
- and very bad.

The first definition classes "fair, bad and very bad" as self-assessed poor relative health. The data are provided in five age-bands:

- 0-15;
- 16-24;
- 25-49;
- 50-64;
- and 65+.

The second definition excludes populations aged 65 and over, in a similar way to the SMR<75. The ratios were created using indirect-standardisation.

The variables used to model the MSOA rate of excess mortality are publicly available, and are factors known to influence geographical variations in excess mortality. We have used the most recent available data where possible and many of the predictors are created using data from the 2011 Census. Multiple variables were available at 2001 statistical geography hierarchy and were collapsed to 2011 geography (MSOAs) using relevant weightings. In some cases, historical measures were included to capture important influences on geographical variations in the rate of excess mortality even though they are less recent as more contemporary measures were not available (such as measures of local levels of indebtedness).

The models presented in this chapter are estimated using weighted linear regression (ordinary least squares), and use robust standard errors.

<u>Using the exponential of the rank to allocate to areas</u>

The current formula uses an exponential set of weights for bins of SMR values, between 1 and 5 (Figure 1). We examined the relationships between the SMR values, ranks, and the exponential of the ranks (Table 3). The value of the SMR, its rank and the exponential of the rank are strongly correlated (Table 3).

The effect of the transformation process is to flatten the gradient of the needs weights for the highest and lowest values of the SMR (Figure 2), such that large changes in the SMR lead to much smaller changes in the target shares for the highest and lowest ranked areas as compared with those in the middle of the distribution. We recommend that this transformation process is not continued.

FIGURE 1 POPULATION HEALTH: CURRENT FORMULA NEEDS WEIGHTS

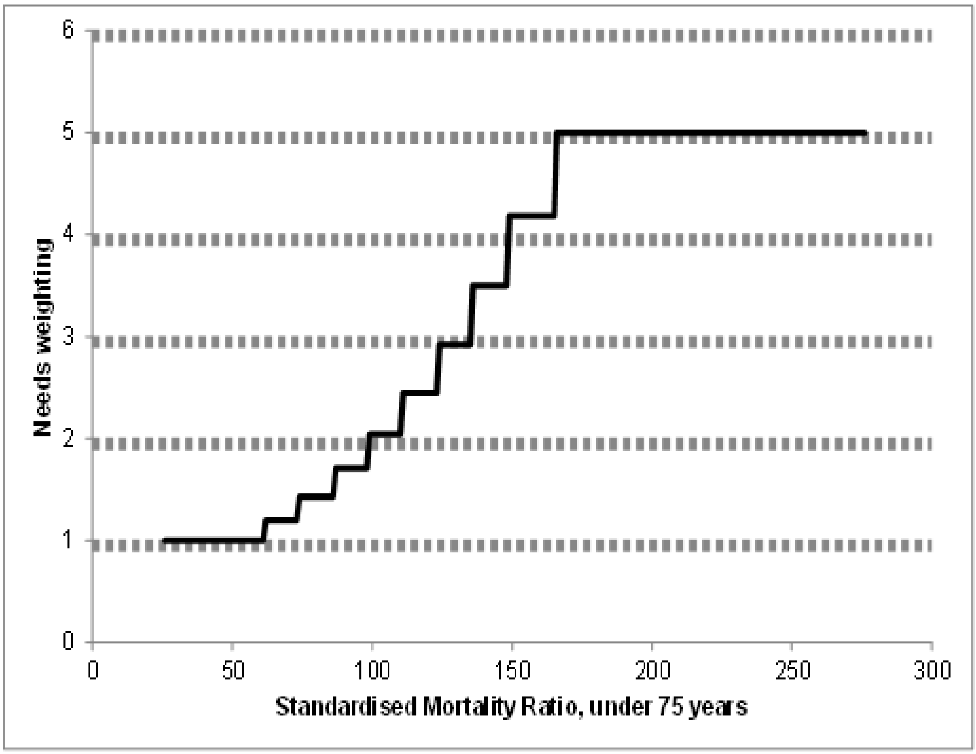
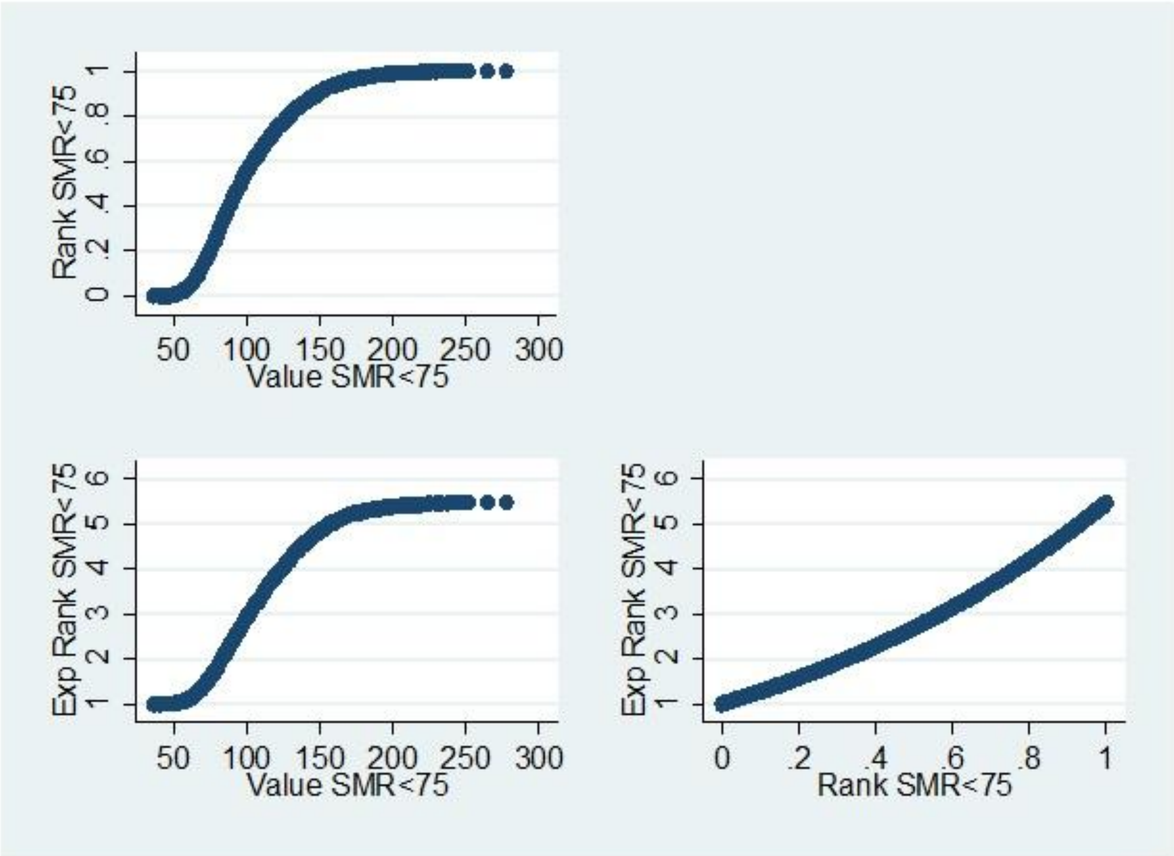


TABLE 3 POPULATION HEALTH: CORRELATION BETWEEN VALUES OF THE SMR, THEIR RANK AND THE EXPONENTIAL OF THE RANKS

	Value	Rank
Rank	0.9443	1
Exp Rank	0.9681	0.9918

FIGURE 2 POPULATION HEALTH: EFFECTS OF EXPONENTIAL TRANSFORMATIONS



PCT fixed effects

Initially, the model controlled for Local Authority fixed effects. This was intended to capture factors that were fixed across MSOAs within a given LA. We replaced these with PCT fixed effects based on feedback from TAG indicating that PCTs were the relevant organisations deciding on supply of public health interventions in the study period. All models in this chapter contain PCT effect unless otherwise indicated.

Historical measures of income deprivation

We also explored the use of measures of income deprivation that were older than the 2010 Income Score. The reasons for doing so were twofold: first, to explore the possibility that mortality might be affected by longer-term socioeconomic status in addition to current or recent socioeconomic status; and second that the 2010 measures might be affected by the consequences of the 2008 global financial crisis. Table 4 shows a comparison of three models. Model I is a univariate linear regression model in which the 2010 income deprivation score is used to explain the MSOA rate of excess mortality for the years 2008-2010. Model II uses the 2007 score instead, and model III includes both. Comparison of I and II reveals that the 2010 score is a stronger predictor of the rate of excess mortality, and III shows that including both causes the coefficient on the 2007 measure to become negative. The standard errors increase in magnitude (to seven times their size in I and II) showing that the estimates are much less precise when both are included, and this leads to the estimate on the 2007 measure being insignificant at the 5% significance level. Including both adds less than 0.1% to the adjusted R-squared, compared to Model I.

Table 4 also indicates that income deprivation alone explains nearly 77% of the variation in excess mortality.

Table 5 shows a comparison of the effects of inclusion of either or both 2010 and 2007 measures in the full model specification. Model I is the full specification including the 2010 income deprivation score. Model II uses the 2007 score instead, and model III includes both. Again, as in the univariate case, the 2010 measure is a stronger predictor of the rate of excess mortality. The 2007 score is not statistically significant at the 1%, 5% or 10% level in Model III, perhaps indicating that its significance at 10% in Model III in Table 4 was the result of its correlation with omitted variables.

Table 6 shows how introducing different variables in the development of the preferred specification changed the parameter estimates. Higher levels of income deprivation are associated with higher rates of excess mortality across models I-IV, and the coefficients and standard errors on the income deprivation variable are relatively unaffected by inclusion of different variables.

Air Pollution

MSOA rates of air pollution were included in the preferred specification based on literature which indicates that differential rates of air pollution impact on mortality in England (Janke et al, 2009). Higher rates of air pollution are associated with higher rates of excess of mortality (Table 6).

Local knowledge and skills

The formula was developed to contain variables that reflected the local 'stock' of knowledge and skills. Two measures were included to reflect knowledge and skills: the percentage of the working population employed in professional/scientific industries; and the percentage of those eligible not continuing in education older than age sixteen.

TABLE 4 POPULATION HEALTH: COMPARISON OF EFFECTS OF HISTORICAL MEASURES OF INCOME DEPRIVATION ON SMR

	I	II	III
Income Score 2010	312.0*** [3.411]		369.9*** [23.38]
Income Score 2007		280.8*** [3.717]	-53.71* [22.11]
Constant	57.09*** [0.446]	59.26*** [0.507]	56.92*** [0.435]
Number of Areas	6789	6789	6789
Adjusted R-squared	0.768	0.751	0.769

TABLE 5 POPULATION HEALTH: COMPARISON OF HISTORICAL MEASURES OF INCOME DEPRIVATION IN FULL SPECIFICATION

	I	II	III
Income Score 2010	146.4***		148.9***
	[9.382]		[21.14]
Income Score 2007		102.3***	-2.122
		[8.077]	[17.46]
Air pollution	8.294***	7.028***	8.312***
	[1.603]	[1.601]	[1.598]
% Prof/Scientific	-0.610***	-0.830***	-0.608***
	[0.120]	[0.119]	[0.120]
% 17+ leaving educ	29.20***	31.33***	29.17***
	[2.070]	[2.066]	[2.065]
% Families rec. WTCs	-0.221***	-0.400***	-0.220***
	[0.0586]	[0.0570]	[0.0577]
% Population rec. JSA	2.370***	3.261***	2.370***
	[0.421]	[0.412]	[0.421]
Migration In 15-24	0.0297***	0.0289***	0.0296***
	[0.00595]	[0.00589]	[0.00595]
Migration In 45-64	0.0803***	0.0875***	0.0802***
	[0.0224]	[0.0226]	[0.0223]
Migration In 65+	0.189***	0.192***	0.189***
	[0.0185]	[0.0184]	[0.0185]
Migration Out 45-64	0.0836***	0.0694**	0.0839***
	[0.0236]	[0.0239]	[0.0236]
Migration Out 65+	-0.0697**	-0.0708**	-0.0695**
	[0.0241]	[0.0244]	[0.0241]
% Occupied homes without central heating	62.69***	60.46***	62.72***
	[16.75]	[17.05]	[16.76]
% Occupied homes with < two bedrooms	26.03***	26.93***	26.02***
	[2.497]	[2.515]	[2.505]
CCJs in 2005	0.0229***	0.0217***	0.0229***
	[0.00515]	[0.00522]	[0.00514]
Constant	42.49***	61.11***	42.33***
	[6.207]	[6.030]	[6.121]
Number of Areas	6789	6789	6789
Adjusted R-squared	0.828	0.826	0.828

TABLE 6 POPULATION HEALTH: DEVELOPMENT OF PREFERRED SPECIFICATION

	I	II	III	IV	V
Income Score 2010	140.7***	154.8***	154.6***	150.8***	149.2***
	[10.41]	[9.378]	[9.390]	[9.334]	[9.338]
Air pollution	19.06***	9.393***	9.205***	7.529***	7.115***
	[1.723]	[1.693]	[1.684]	[1.655]	[1.650]
% Prof/Scientific	-0.394**	-0.527***	-0.584***	-0.692***	-0.643***
	[0.130]	[0.129]	[0.129]	[0.129]	[0.129]
% 17+ leaving educ	21.01***	33.41***	31.90***	29.01***	28.42***
	[2.184]	[2.120]	[2.111]	[2.131]	[2.125]
% Families rec. WTCs	0.488***	-0.279***	-0.305***	-0.267***	-0.220***
	[0.0650]	[0.0581]	[0.0581]	[0.0580]	[0.0582]
% Population rec. JSA	5.448***	2.630***	2.539***	2.511***	2.272***
	[0.450]	[0.416]	[0.419]	[0.416]	[0.423]
Migration In 1-14		-0.0399**	0.0411***	-0.021	-0.0186
		[0.0122]	[0.0122]	[0.0121]	[0.0121]
Migration In 15-24		0.0540***	0.0513***	0.0365***	0.0335***
		[0.00723]	[0.00718]	[0.00715]	[0.00712]
Migration In 25-44		0.00366	0.00756	0.00225	0.00576
		[0.0136]	[0.0135]	[0.0133]	[0.0133]
Migration In 45-64		0.160***	0.148***	0.0763**	0.0798***
		[0.0229]	[0.0229]	[0.0235]	[0.0235]
Migration In 65+		0.199***	0.204***	0.188***	0.189***
		[0.0188]	[0.0190]	[0.0187]	[0.0186]
Migration Out 1-14		0.0524***	0.0452***	0.0257*	0.0205
		[0.0120]	[0.0120]	[0.0119]	[0.0120]
Migration Out 15-24		0.0312***	0.0302***	-0.0171*	-0.0147
		[0.00803]	[0.00798]	[0.00800]	[0.00796]
Migration Out 25-44		0.0151	0.015	0.0168	0.0204
		[0.0124]	[0.0123]	[0.0121]	[0.0121]
Migration Out 45-64		0.0839**	0.0674*	0.0670*	0.0559*
		[0.0268]	[0.0269]	[0.0267]	[0.0267]
Migration Out 65+		-0.0683**	-0.0748**	-0.0751**	-0.0735**
		[0.0247]	[0.0245]	[0.0242]	[0.0242]
% Occupied homes without central heating			91.22***	62.11***	60.92***
			[16.70]	[16.85]	[16.82]
% Occupied homes with two or less bedrooms				24.61***	23.84***
				[2.522]	[2.527]
CCJs in 2005					0.0220***
					[0.00521]
Constant	78.38***	49.28***	52.40***	49.52***	44.76***
	[6.911]	[6.242]	[6.241]	[6.195]	[6.220]
Number of Areas	6789	6789	6789	6789	6789
Adjusted R-squared	0.791	0.824	0.825	0.828	0.828

Areas with higher proportions of the working population working in scientific and professional industries were associated with lower rates of excess mortality (Table 6). The effect size increases in magnitude when age-specific rates of inwards and outwards migration are introduced into the model. This may be due to the correlation between labour market composition and migration.

In and out-of-work poverty

We have included additional measures of in and out-of-work poverty based on concerns that income deprivation might not fully reflect these socioeconomic factors. We therefore included a measure of working amongst the poor (the percentage of families in receipt of working tax credits), in addition to the percentage of the working age population in receipt of Job Seeker's Allowance.

For models II-V, higher rates of working amongst the poor are associated with lower rates of excess mortality (Table 6). However, for model I, which excludes inwards and outwards migration; the association is positive. This may because rates of working amongst the poor are correlated with age-specific rates of inwards and outwards migration.

Areas with higher rates of Job Seeker's Allowance claimants in the working population are associated with higher rates of excess mortality (Table 6).

Inward and outward migration by age

We also included measures of population turnover based on concerns that mortality might be affected by inward and outward migration. We include both rates of population inflow and outflow for different age groupings, to reflect the potential differential effects of inwards and outwards migration rates across different ages (which could be masked by a net figure across all ages).

Higher rates of inwards migration amongst the groups aged 15-24, 45-64, and 65 and over were associated with higher rates of excess mortality (Table 6). The effect sizes are much stronger for the groups aged 45-64 and 65 and over. The effects are less pronounced for outwards migration and there are fewer clearer patterns in the results, though it appears that higher rates of outwards migration in the oldest age group are associated with lower rates of excess mortality.

Fuel poverty, overcrowding and indebtedness

Three factors that have been identified as important drivers of health inequalities and geographical variations in excess mortality are fuel poverty, overcrowding (and per person family resources more generally) and indebtedness. To deal with the first, we included a variable which measures the percentage of occupied homes without central heating for MSOAs. Second, we included the percentage of occupied homes with two or less bedrooms. Finally, we used the most recent measure available at the required geographical refinement, which was the MSOA rate of county court judgments (CCJs) in 2005.

Each of these variables was found to be significant at 0.1% and had the expected effect on excess mortality. A higher rate of occupied homes without central heating is associated with higher rates of excess mortality (Table 6).

An increase in the percentage of occupied homes without two or less bedrooms is associated with higher rates of excess mortality (Table 6).

Indebtedness is also positively correlated with rates of excess mortality (Table 6).

Exploration of alternatives to the MSOA rate of excess mortality

Focusing only on the rate of excess mortality as the dependent variable might fail to adequately reflect mental health. We therefore explored models using self-assessed health.

Columns I and IV of Table 7 use the MSOA rate of excess mortality as the dependent variable. Columns II and V use the first definition, which classes "fair, bad and very bad" as self-assessed poor relative health. Columns III and VI use the same definition but exclude the age group aged 65 and over, similar to the SMR<75.

The explanatory power of the models using self-assessed health is much improved compared with using the SMR. Models II, III, V and VI in Table 7 explain on average 94% of the variation in the dependent variable. Model IV (the preferred specification) explains nearly 83% of the variation in the SMR.

TABLE 7 POPULATION HEALTH: COMPARISON OF MODELS FOR SMR AND SELF ASSESSED HEALTH

	I	II	III	IV	V	VI
Income Score 2010	312.0***	270.2***	340.7***	146.4***	195.2***	234.6***
	[3.411]	[1.675]	[2.219]	[9.382]	[4.445]	[5.801]
Air pollution				8.294***	7.479***	2.622**
				[1.603]	[0.718]	[0.933]
% Prof/Scientific				-0.610***	-1.788***	-2.139***
				[0.120]	[0.0592]	[0.0755]
% 17+ leaving educ				29.20***	18.18***	21.29***
				[2.070]	[0.966]	[1.239]
% Families rec. WTCs				-0.221***	-0.159***	-0.439***
				[0.0586]	[0.0290]	[0.0374]
% Population rec. JSA				2.370***	-0.672***	-0.424
				[0.421]	[0.182]	[0.242]
Migration In 15-24				0.0297***	0.00684**	0.0123***
				[0.00595]	[0.00218]	[0.00297]
Migration In 45-64				0.0803***	0.000555	0.0132
				[0.0224]	[0.00999]	[0.0137]
Migration In 65+				0.189***	0.0233***	0.0305***
				[0.0185]	[0.00527]	[0.00680]
Migration Out 45-64				0.0836***	0.000671	-0.0197
				[0.0236]	[0.00960]	[0.0127]
Migration Out 65+				-0.0697**	0.000434	0.00585
				[0.0241]	[0.0106]	[0.0137]
% Occupied homes without central heating				62.69***	14.06	53.49***
				[16.75]	[7.310]	[10.08]
% Occupied homes with < two bedrooms				26.03***	13.91***	12.35***
				[2.497]	[1.104]	[1.452]
CCJs in 2005				0.0229***	0.00227	-0.000478
				[0.00515]	[0.00252]	[0.00328]
Constant	57.09***	61.24***	49.50***	42.49***	72.85***	91.16***
	[0.446]	[0.239]	[0.309]	[6.207]	[3.012]	[3.906]
Number of Areas	6789	6789	6789	6789	6789	6789
Adjusted R-squared	0.768	0.917	0.918	0.828	0.953	0.949

Exploring non-linearity

Some variables might exhibit a non-linear relationship with the rate of excess mortality. We investigated this by taking variables in the preferred specification in order of statistical significance and testing, in the preferred specification, the powers of each variable for increments of 0.1 between values of 0.1 and 5. We then created a non-linear transformation of the variable for the value of the power function which maximized the adjusted R-squared. This process was repeated until, for the variable of smallest statistical significance from the preferred specification, we found the value of the power function which maximized the adjusted R-squared and each variable had undergone a non-linear transformation.

We present the coefficients from the non-linear and linear models in Table 8. The adjusted R-squared is hardly increased at all and the transformations increase the complexity in interpreting the parameter estimates. We therefore do not believe that a model including non-linear effects is warranted.

TABLE 8 POPULATION HEALTH: COMPARISON OF LINEAR AND NON-LINEAR MODELS

	Non-linear	Linear
Income Score 2010	139.9***	146.4***
	[7.795]	[9.382]
Air pollution	75.33***	8.294***
	[13.88]	[1.603]
% Prof/Scientific	-10.22***	-0.610***
	[1.654]	[0.120]
% 17+ leaving educ	26.72***	29.20***
	[2.127]	[2.070]
% Families rec. WTCs	-0.00000382	-0.221***
	[0.00000295]	[0.0586]
% Population rec. JSA	3.641***	2.370***
	[0.645]	[0.421]
Migration In 15-24	0.0973***	0.0297***
	[0.0182]	[0.00595]
Migration In 45-64	0.000186	0.0803***
	[0.000142]	[0.0224]
Migration In 65+	1.368***	0.189***
	[0.0968]	[0.0185]
Migration Out 45-64	0.0000141***	0.0836***
	[0.00000345]	[0.0236]
Migration Out 65+	-0.00106***	-0.0697**
	[0.000305]	[0.0241]
% Occupied homes without central heating	18.84**	62.69***
	[5.848]	[16.75]
% Occupied homes with < two bedrooms	42.83***	26.03***
	[3.908]	[2.497]
CCJs in 2005	4.268***	0.0229***
	[1.023]	[0.00515]
Constant	-38.54*	42.49***
	[15.67]	[6.207]
Number of Areas	6789	6789
Adjusted R-squared	0.833	0.828

Overall fit of preferred specification

The preferred specification has an adjusted R-squared of 0.828, indicating that nearly 83% of the variation in the MSOA rate of excess mortality is explained by the model.

Regional comparisons at higher level geography

We also repeated models I-V contained in Table 6 using dummy variables for nine government office regions of England in place of PCT fixed effects (Table 9). We have transformed the nine regional dummy variables so that they reflect deviations from the 'grand mean' rather than deviations from the reference category and adds the coefficient for the reference category (the variance-covariance matrix of the estimates is transformed accordingly).

These models demonstrate a clear regional pattern in unexplained variation in all of the models. We find that the SMR in MSOAs in London is systematically over-predicted and the SMRs in MSOAs in the North West, the North East and Yorkshire and Humberside are systematically under-predicted.

There are two possible explanations for these systematic patterns. The first is that the historic efforts of public health bodies have led to better than expected outcomes in London and worse than expected outcomes in the North, even accounting for a rich set of risk factors for poor health. The second is that there are needs-related causes of poor health that are omitted from the datasets that we have been able to source for this analysis. Our assessment is that the second explanation is more likely. This would tend to the decision to use the observed values of the SMR for allocating funds for population health rather than modelled values until models that avoid this systematic pattern are identified.

TABLE 9 POPULATION HEALTH: COMPARISON OF REGION EFFECTS IN DIFFERENT SPECIFICATION (NO PCT EFFECTS)

	I	II	III	IV	V
East Midlands	3.264***	2.571***	2.874***	3.294***	2.357***
	[0.587]	[0.543]	[0.547]	[0.545]	[0.554]
East of England	-5.376***	-7.182***	-6.909***	-6.311***	-6.229***
	[0.481]	[0.481]	[0.485]	[0.484]	[0.482]
London	-17.04***	-15.08***	-15.28***	-15.97***	-15.27***
	[0.802]	[0.770]	[0.770]	[0.785]	[0.781]
North East	5.168***	9.239***	9.922***	7.737***	8.442***
	[0.822]	[0.777]	[0.799]	[0.806]	[0.817]
North West	12.80***	14.92***	14.65***	14.51***	15.04***
	[0.558]	[0.510]	[0.510]	[0.506]	[0.509]
South East	-1.157*	-4.585***	-4.459***	-3.751***	-3.485***
	[0.454]	[0.446]	[0.446]	[0.449]	[0.448]
South West	-1.105*	-6.619***	-7.053***	-6.059***	-6.470***
	[0.562]	[0.542]	[0.557]	[0.562]	[0.562]
West Midlands	-2.238***	0.432	0.242	0.797	0.113
	[0.576]	[0.520]	[0.522]	[0.507]	[0.506]
Yorkshire & Humberside	5.683***	6.298***	6.010***	5.761***	5.500***
	[0.553]	[0.524]	[0.527]	[0.518]	[0.518]

DRUGS AND ALCOHOL SERVICE FORMULA

This chapter discusses the data sources, methods for costing, and econometric applications used to generate weights for the drug and alcohol component of the formula for the Public Health budget for England.

BACKGROUND

Drug and alcohol treatment in England is classified into four tiers of treatment intensity (NTA, 2006). Tier 1 intervention is provided in primary care settings by non-specialists and comprises information, advice, screening and referral. Tier 2 provides low-intensity specialist input and comprises brief interventions and harm reduction services (e.g. needle exchanges). Tier 3 covers structured community-based services and Tier 4 covers residential treatment.

ACTIVITY DATA

For the drugs and alcohol misuse services formula, the utilisation data were sourced from the National Drug Treatment Monitoring System (NDTMS). This provides micro-level data on people receiving Tier 3 or 4 treatment for drug and alcohol misuse in England and is used to report on alcohol treatment activity, drug treatment activity and young people in specialist drug and alcohol services. Those aged younger than 9yrs or older than 75yrs at the point of triage are excluded from the NDTMS dataset.

We acquired 2011/12 data and 2013/14 data from NDTMS. Our preference was to use the most recent 2013/14 data, but this incorporates a change in the coding of treatment interventions (to include three high-level intervention types, specifically psychosocial, pharmacological and recovery support (PHE, 2014a). The 2011/12 dataset is the most recent data available prior to this coding change, in which the intervention codes in the source data match those for which mean day costs are available. Average day costs per individual structured drug and alcohol treatment intervention were obtained from Public Health England (PHE), based on a survey of treatment agencies in 2008/09, to which inflationary uplifts were applied by PHE. Use of the 2013/14 data required a restructuring of the intervention codes to match the available cost data. We therefore sought to compare models using the 2013/14 data with that using 2011/12 data in order to validate the 2013/14 data.

The 2013/14 dataset covers approximately 319,000 clients engaging in approximately 413,000 drug and alcohol treatment episodes. NDTMS coverage is considered near comprehensive for Tier 3 and 4 services. Total costs accounted for by NDTMS-recorded interventions in 2011/12 were £843 million and in 2013/14 were £920 million[2].

[2] This estimation of costs exceeds the known budget for the period. This may be due to overestimation of daily costs or of days in treatment. The overestimation applies to both the numerator and denominator of the cost ratio and is not subject to any known area-level bias.

MODELLING APPROACH

Available data were modelled using three different approaches:

MODEL 1. AGE-STANDARDISED MODEL

The dependent variable is the ratio of actual to expected cost. Expected cost was obtained by calculating costs per capita by eight age bands (under 15, 15 to 19, 20 to 24, 25 to 29, 30 to 44, 60 to 64, 65 and above) and applying these age weights to each area, using 2011 population data (ONS). Need and supply variables at area level were then tested to explore how well they predicted the actual to expected cost ratio. The analyses were weighted by the expected costs for each area.

MODEL 2. AGE-STRATIFIED MODEL

Different area-level variables may explain variations in needs for different age groups. The characteristics of younger clients in treatment suggest that the under-18s, in particular, as a group may differ from the over-18s. We therefore carried out separate analyses for the over-18s and under-18s.

MODEL 3. PERSON-BASED MODEL

The dependent variable is the level of cost, not a cost ratio. Case-level data for those with treatment records are combined with data grouped by area and age group for those with no treatment records; the population of each provides the appropriate weighting. Indicator variables are applied at the level of area/age group. Past-year treatment utilisation is applied at case level.

Each modelling approach used standard linear regression analysis (accounting for UTLA[3] level) and used the R-squared statistic to estimate the amount of variation explained. Analyses were carried out using SPSS version 20 and STATA version 13.

[3] Upper Tier Local Authority: the administrative area responsible for commissioning drug and alcohol treatment provision.

DATA PREPARATION AND CLEANING

Our unit of analysis was the postcode sector/ local authority (LA) combination (n = 10 039 areas). Predictor variables were identified via a search of the existing literature and are listed in the Appendix.

Drug treatment clients are characterised by male gender, white ethnicity, involvement in crime, poor mental and physical health, unstable accommodation, unemployment, receipt of welfare benefits and previous drug treatment episodes (Jones et al, 2007; Gossop et al, 1998). Drug and alcohol misuse in the community has been associated with a number of additional factors, including population density (Adger, 1991), urbanicity (Galea, 2004), neighbourhood instability (Stone et al, 2012), homelessness (Bravender and Knight, 1998), low socio-economic status (Galea, 2004), disadvantaged background (Degenhardt and Hall, 2012), poor school performance (Degenhardt and Hall, 2012), teenage pregnancy (Pumariega et al, 2004) and single parenting (Galea, 2004).

The needs of young people attending drug services can differ from those of adult clients, in particular, young people are more likely to present with problematic cannabis use compared with adult clients and less likely to present with problematic use of alcohol (Sinha et al, 2003).

A database of potential needs variables was constructed using Neighbourhood Statistics. Where data points were missing because of changes to output areas, 2011 area data were calculated according to comparisons between 2001 and 2011 output areas available from the ONS (ONS, 2012) and ONS best-fit lookup files. Any remaining missing data points were calculated based on the mean score of neighbouring output areas. LSOA-, MSOA- and LA-level predictor variables were mapped into NDTMS areas by weighting on postcode populations (Nomis, ONS).

Costs which could not be assigned to an area due to the agency not recording a location were redistributed across areas using the distribution of cases in which area information was known. Where postcode sector was not recorded, costs were redistributed within the local authority, weighted by known treatment costs by age group within that local authority. Where local authority was missing, costs were redistributed nationally, weighted by known treatment costs by age group nationally.

Seven per cent (673/10 039) of areas comprised very small (n < 30) populations. Extreme values of the cost ratio were more likely in these areas, which could exert undue leverage on the model. Consequently, these areas were excluded from the analyses for Model 1. Similarly, in Model 2 areas with small (n < 30) adult (18+) populations (760) and under-18 populations (1333) were excluded. No such restrictions were placed on the analysis for Model 3.

ANALYSIS

We firstly developed a model for combined primary drug and alcohol misuse data using the most recent data from 2013/14 and compared the performance of this model to that using 2011/12 data.

MODEL 1. AGE-STANDARDISED MODEL

Table 10 and Figures 3 to 4 show the age weights (costs per capita) obtained from NDTMS and used to calculate the expected cost for drug misuse, alcohol misuse, and drug and alcohol misuse combined for each postcode sector/ local authority combination area over the two time-periods examined.

TABLE 10 DRUGS AND ALCOHOL: COSTS PER CAPITA (£) FOR DRUG AND ALCOHOL MISUSE BY AGE GROUP

	Drugs (£)		*Alcohol (£)*		*Drugs & Alcohol (£)*	
Age Group (yrs)	*2011/12*	*2013/14*	*2011/12*	*2013/14*	*2011/12*	*2013/14*
Under 15	0.69	0.75	0.31	0.19	1.00	0.94
15-19	4.02	3.54	1.41	0.82	5.44	4.37
20-24	10.08	8.00	1.90	1.20	11.98	9.20
25-29	25.13	22.25	3.45	2.48	28.57	24.73
30-44	35.05	40.09	6.94	5.00	41.99	45.10
45-59	9.18	13.51	5.99	4.95	15.17	18.45
60-64	1.27	2.10	2.18	1.86	3.45	3.96
65 and above	0.11	0.23	0.49	0.49	0.61	0.71

FIGURE 3 DRUGS AND ALCOHOL: MEAN COSTS PER CAPITA FOR DRUG MISUSE TREATMENT BY AGE GROUP (2013/14 DATA)

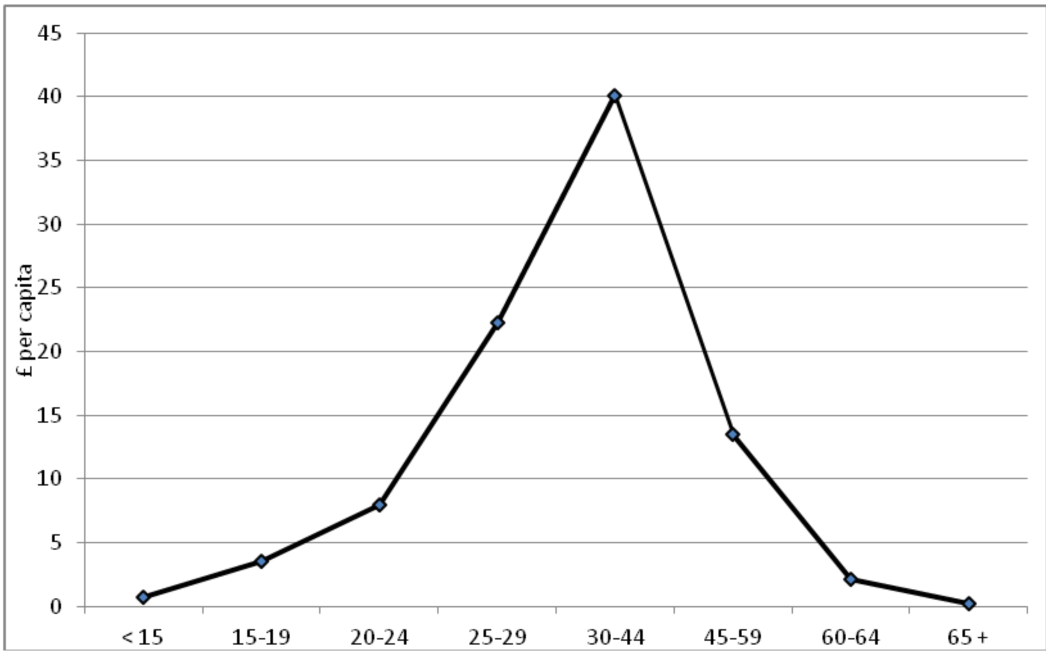
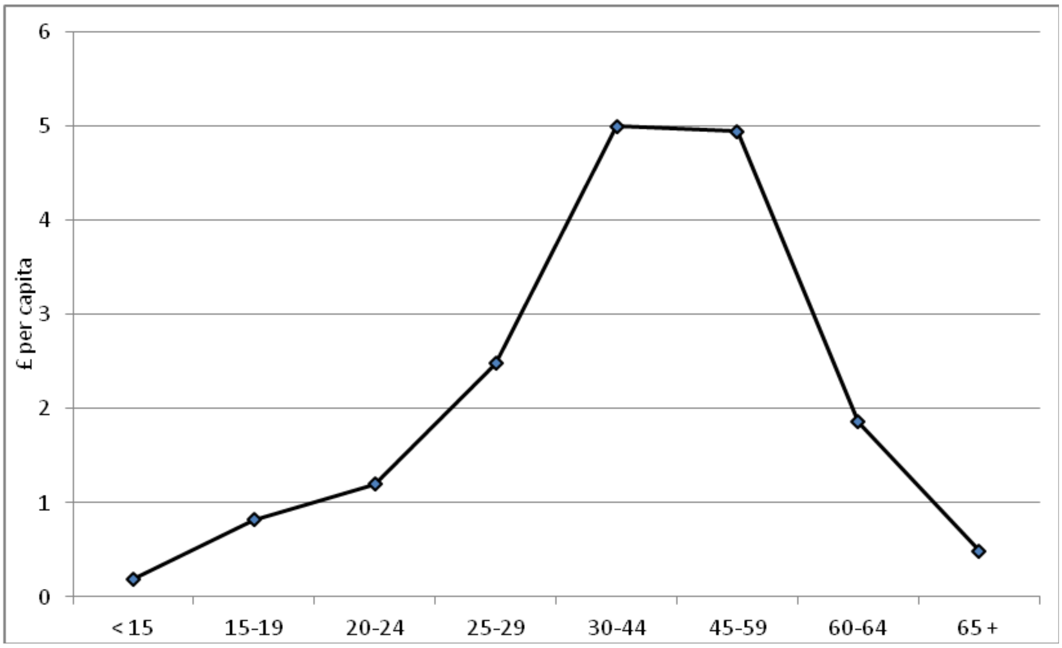


FIGURE 4 DRUGS AND ALCOHOL: MEAN COSTS PER CAPITA FOR ALCOHOL MISUSE TREATMENT BY AGE GROUP (2013/14 DATA)



Variable selection

Our approach to variable selection was to initially carry out a series of stepwise regressions to examine relationships between the dependent variable (cost ratio) and potential predictors (see the Appendix for a full list of covariates). Relative effect of each predictor was assessed by converting all variables to *z*-scores. Predictors exhibiting collinearity (VIF of greater than 5.0) were removed.

The indirectly-standardised cost ratio was assessed for non-linearity prior to entering our selected variables into a standard linear regression analysis (weighted by expected cost and accounting for UTLA[4] level: Table 11) to identify the best predictors (using the R-squared statistic). Supply variables included mean waiting times, the proportion of prescribing comprising GP prescribing and the distance (in kilometres) from post sector centroid to post code of the nearest drug service.

Table 11 highlights that the local authority variation adds substantially to the R-squared value. Adding in local authority fixed effects increases the slope of the regression line; the relationship between the predictor variable – SMR and costs is stronger within local authorities than between them.

The model performs similarly for data covering both time-periods with an adjusted R-squared of 0.522 obtained using 2013/14 data (Table 12) compared with an adjusted R-squared of 0.520 using 2011/12 data (Table 13). We therefore proceeded to develop further models using the more recent 2013/14 data. A correlation of 0.793 was observed between 2011/12 cost ratios and 2013/14 cost ratios, weighted by 2013/14 expected cost data. Table A3 in the Appendix shows the correlation between predictor variables.

[4] Upper Tier Local Authority: the administrative area responsible for commissioning drug and alcohol treatment provision

TABLE 11 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE. EFFECT OF CONTROLLING FOR UTLA[A]

Variable	Models	
	Without UTLA absorb	With UTLA absorb
SMR	0.023	0.025
	[0.000]	[0.001]
Constant	-1.314	-1.510
	[0.043]	[0.049]
Number of areas	9366	9366
R-squared	0.362	0.478
Adjusted R-squared	---	0.470

Notes: [a] Upper Tier Local Authority: the administrative area responsible for commissioning drug and alcohol treatment provision. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]

TABLE 12 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE. ALL AGES, 2013/14 DATA

Variable	i	ii	iii	iv	v	vi	vii	viii	ix	x
SMR [a]	0.025	0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
IMD Crime		0.501	0.427	0.427	0.438	0.418	0.414	0.407	0.389	0.389**
		[0.025]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]
Population turnover [b]			0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006**
			[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Proportion white British [5]				0.500	0.646	0.775	0.790	0.806	0.828	0.829**
				[0.090]	[0.092]	[0.094]	[0.093]	[0.093]	[0.093]	[0.093]
Proportion male					4.064	4.435	4.174	4.146	4.181	4.189**
					[0.856]	[0.865]	[0.861]	[0.863]	[0.863]	[0.862]
IMD Income						0.747	0.632	0.629	0.630	0.631**
						[0.115]	[0.120]	[0.119]	[0.119]	[0.119]
IMD Environment							0.003	0.003	0.003	0.003**
							[0.001]	[0.001]	[0.001]	[0.001]
Proportion of GP prescribing								-0.585	-0.572	-0.571**
								[0.051]	[0.051]	[0.051]
Distance to nearest service [c]									-0.01	-0.01**
									[0.002]	[0.002]
Mean waiting time										-0.002
										[0.001]
Constant	-1.510	-0.740	-1.034	-1.554	-3.619	-3.913	-3.819	-3.777	-3.759	-3.747
	[0.049]	[0.060]	[0.067]	[0.122]	[0.458]	[0.465]	[0.463]	[0.463]	[0.464]	[0.463]
Number of areas	9366	9366	9366	9366	9366	9366	9366	9366	9366	9366
Adj R-squared	0.470	0.498	0.508	0.510	0.514	0.516	0.517	0.521	0.522	0.522

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

[5] Table A4 in the Appendix presents the model incorporating additional ethnic categories.

TABLE 13 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE. ALL AGES, 2011/12 DATA

Variable	i	Ii	iii	Iv	v	vi	vii	viii	ix	x
SMR [a]	0.025	0.019	0.018	0.018	0.018	0.017	0.017	0.017	0.017	0.017**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	0.001	[0.001]	[0.001]
IMD Crime		0.415	0.357	0.357	0.367	0.342	0.338	0.334	0.316	0.316**
		[0.026]	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]	0.026	[0.026]	[0.026]
Population turnover [b]			0.004	0.005	0.005	0.005	0.005	0.005	0.004	0.004**
			[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	0.001	[0.001]	[0.001]
Proportion white British				0.529	0.667	0.829	0.843	0.853	0.876	0.877**
				[0.101]	[0.102]	[0.104]	[0.103]	0.103	[0.103]	[0.103]
Proportion male					3.815	4.289	4.066	4.043	4.081	4.088**
					[0.930]	[0.940]	[0.940]	0.942	[0.941]	[0.941]
IMD Income						0.937	0.840	0.838	0.840	0.839**
						[0.123]	[0.127]	0.126	[0.126]	[0.126]
IMD Environment							0.002	0.002	0.003	0.003**
							[0.001	0.001	[0.001]	[0.001]
Proportion of GP prescribing								-0.391	-0.378	-0.378**
								0.053	0.053	0.053
Distance to nearest service [c]									-0.010	-0.010**
									[0.002]	[0.002]
Mean waiting time										-0.001
										[0.001]
Constant	-1.574	-0.942	-1.169	-1.720	-3.660	-4.034	-3.954	-3.924	-3.907	-3.899
	[0.057]	[0.071]	[0.076]	[0.136]	[0.501]	[0.509]	[0.508]	0.509	[0.509]	[0.509]
Number of areas	9366	9366	9366	9366	9366	9366	9366	9366	9366	9366
Adj R-squared	0.487	0.504	0.509	0.511	0.514	0.518	0.518	0.519	0.520	0.520

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

Levels of utilisation of drugs and alcohol interventions have different distributions by age and are likely to have different small-area predictors. We therefore also estimated separate models for drug and alcohol services.

Tables 14 and 15 indicate that predictors common to both the drugs and the alcohol misuse models are SMR, IMD Crime, IMD Environment, population turnover, proportion male and proportion white British. A significant predictor in the drugs but not the alcohol model is IMD Income. The final alcohol model contained the IMD mood and anxiety indicator, which was not a significant predictor in the drugs model. The final model achieves an adjusted R-squared of 0.513 for the drugs cost ratio but performs less well for the alcohol cost ratio (adjusted R-squared of 0.334).

TABLE 14 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG MISUSE. ALL AGES (2013/14 DATA)

Variable	i	ii	iii	iv	v	vi	vii	viii	ix	x
SMR [a]	0.026	0.018	0.016	0.017	0.017	0.016	0.015	0.016	0.016	0.016**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
IMD Crime		0.525	0.452	0.452	0.463	0.441	0.437	0.428	0.410	0.410**
		[0.027]	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]	[0.026]
Population turnover [b]			0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.005**
			[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Proportion white British				0.482	0.630	0.773	0.787	0.806	0.829	0.828**
				[0.097]	[0.099]	[0.101]	[0.101]	[0.100]	[0.100]	[0.100]
Proportion male					4.070	4.487	4.252	4.198	4.234	4.233**
					[0.883]	[0.891]	[0.889]	[0.891]	[0.890]	[0.891]
IMD Income						0.831	0.728	0.723	0.724	0.723**
						[0.126]	[0.131]	[0.130]	[0.130]	[0.130]
IMD Environment							0.003	0.003	0.003	0.003**
							[0.001]	[0.001]	[0.001]	[0.001]
Proportion of GP prescribing								-0.612	-0.601	-0.601**
								[0.050]	[0.050]	[0.050]
Distance to nearest service [c]									-0.011	-0.011**
									[0.002]	[0.002]
Mean waiting time										0.001
										[0.001]
Constant	-1.632	-0.831	-1.119	-1.621	-3.689	-4.019	-3.934	-3.873	-3.855	-3.856
	[0.054]	[0.065]	[0.072]	[0.130]	[0.475]	[0.482]	[0.480]	0.480	[0.481]	[0.481]
Number of areas	9366	9366	9366	9366	9366	9366	9366	9366	9366	9366
Adj R-squared	0.464	0.491	0.500	0.502	0.504	0.507	0.508	0.512	0.513	0.513

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells represent models using additional supply variables.

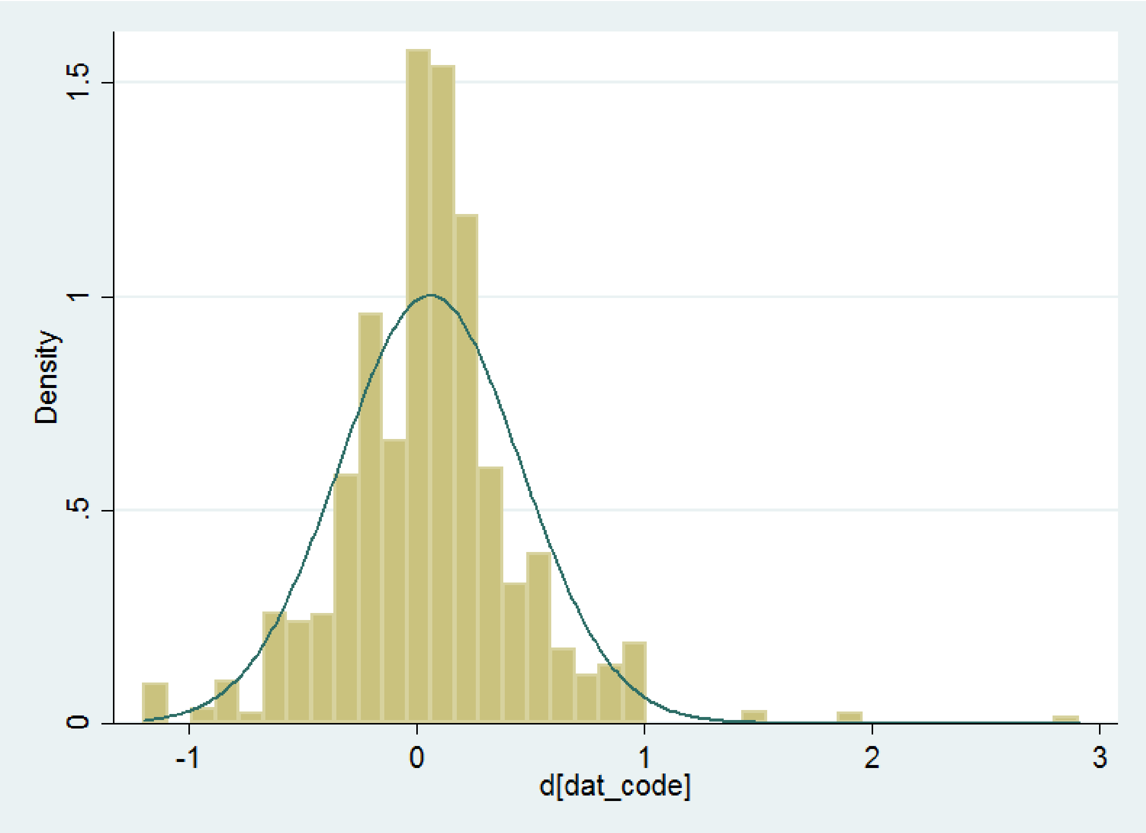
TABLE 15 DRUGS AND ALCOHOL: REGRESSION MODELS: ALCOHOL MISUSE. ALL AGES (2013/14 DATA)

Variable	i	ii	iii	iv	v	vi	vii	viii	ix	x
SMR [a]	0.019	0.013	0.012	0.011	0.010	0.011	0.011	0.011	0.011	0.011**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
IMD Crime		0.396	0.311	0.278	0.283	0.293	0.288	0.285	0.272	0.273**
		[0.030]	[0.029]	[0.029]	[0.030]	[0.030]	[0.030]	[0.029]	[0.030]	[0.030]
Population turnover [b]			0.007	0.007	0.006	0.007	0.007	0.007	0.007	0.007**
			[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
IMD Mood & Anxiety				0.147	0.155	0.149	0.132	0.133	0.128	0.128**
				[0.022]	[0.022]	[0.022]	[0.022]	[0.022]	[0.022]	[0.022]
Proportion male					3.194	4.226	3.933	3.928	3.937	3.953**
					[1.032]	[1.102]	[1.095]	[1.095]	[1.096]	[1.095]
Proportion white British						0.590	0.644	0.651	0.674	0.669**
						[0.106]	[0.108]	[0.108]	[0.108]	[0.108]
IMD Environment							0.003	0.003	0.004	0.004**
							[0.001]	[0.001]	[0.001]	[0.001]
Proportion of GP prescribing								-0.244	-0.234	-0.233**
								[0.063]	[0.063]	[0.063]
Distance to nearest service [c]									-0.008	-0.007*
									[0.003]	[0.003]
Mean waiting time										-0.003*
										[0.001]
Constant	-0.928	-0.304	-0.732	-0.615	-2.111	-3.203	-3.144	-3.130	-3.119	-3.098
	[0.065]	[0.079]	[0.092]	[0.094]	[0.502]	[0.584]	[0.579]	[0.579]	[0.580]	[0.580]
Number of areas	9366	9366	9366	9366	9366	9366	9366	9366	9366	9366
Adjusted R-squared	0.302	0.314	0.326	0.329	0.331	0.333	0.334	0.334	0.334	0.334

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Inflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

Figure 5 illustrates the distribution of the upper-level supply effect.

FIGURE 5 DRUGS AND ALCOHOL: DISTRIBUTION OF UPPER-LEVEL SUPPLY EFFECT



CONSIDERATION OF PREVENTION

The models constructed here predict variations in the cost of treatment provision. In the absence of known budgets or spend specifically for the prevention of drug or alcohol misuse we could not test for predictors of these. As a means to assess whether the models constructed to predict cost were appropriate to prevention, we tested their predictive power in relation to treatment incidence rates. The known level of new treatment cases (treated for the first time during 2013/14: 21.5%) was divided by the expected level, based on age-standardised per capita costs.

Table A5 in the Appendix shows that four of the seven needs variables which predict variation in the cost ratio were also significant predictors in the treatment incidence model. Non-significant predictors in the incident models were population turnover, proportion male and IMD Income (drug and alcohol misuse combined), population turnover, IMD Income and IMD Environment (drug misuse) and population turnover, proportion male and IMD Environment (alcohol misuse). For supply variables, distance to service remains significant whilst proportion of GP prescribing becomes insignificant, in all three models. Mean waiting time remains significant in the alcohol model, remains insignificant in the drugs model and becomes significant in the combined model.

MODEL 2. AGE-STRATIFIED MODEL

The explanatory power of Model 1 for drugs and alcohol misuse combined and drugs and alcohol misuse considered separately was applied separately to young people (aged less than 18yrs) and adults (aged 18yrs and above) (Table 16).

Table 16 highlights that the removal of the under-18s from the all-age group improves the predictive power of the drug and alcohol misuse model (from an adjusted R-squared of 0.522 in the all-age group to 0.533 in the over-18s group). The all-age model performs less well with the under-18s group with an adjusted R-squared of 0.232. Variables which are significant predictors of the over-18s group are not significant in the under-18s (IMD Income, IMD Environment, proportion male, proportion GP prescribing and distance to nearest service). Mean waiting time is not significant in the over-18s but is in the under-18s.

TABLE 16 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE STRATIFIED BY AGE (2013/14 DATA)

Variable	All ages	Over 18yrs	Under 18yrs
SMR [a]	0.015**	0.017**	0.006**
	[0.001]	[0.001]	[0.001]
IMD Crime	0.389**	0.451**	0.261**
	[0.024]	[0.027]	[0.037]
Population turnover [b]	0.006**	0.005**	0.005**
	[0.001]	[0.001]	[0.001]
Proportion white British	0.829**	0.535**	1.177**
	[0.093]	[0.111]	[0.160]
Proportion male	4.189**	6.339**	1.661
	[0.862]	[1.020]	[1.151]
IMD Income	0.631**	0.731**	-0.020
	[0.119]	[0.138]	[0.216]
IMD Environment	0.003**	0.004**	0.002
	[0.001]	[0.001]	[0.001]
Proportion of GP prescribing	-0.571**	-0.630**	0.148
	[0.051]	[0.059]	[0.107]
Distance to nearest service [c]	-0.01**	-0.01**	-0.006
	[0.002]	[0.002]	[0.004]
Mean waiting time	-0.002	-0.002	-0.008**
	[0.001]	[0.001]	[0.002]
Constant	-3.747	-4.648	-1.808
	[0.463]	[0.544]	[0.603]
Number of areas [d]	9366	9279	8706
Adj R-squared	0.522	0.533	0.232

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. [d] Number of areas differs due to the removal of areas with very low populations. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

Table 17 highlights that the removal of the under-18s from the all-age group improves the predictive power of the drug misuse model (from an adjusted R-squared of 0.513 in the all-age group to 0.526 in the over-18s group). The all-age model performs less well with the under-18s group with an adjusted R-squared of 0.169. Variables which are significant predictors of the over-18s group are not significant in the under-18s (IMD Income, IMD Environment, proportion male, proportion GP prescribing and distance to nearest service).

TABLE 17 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG MISUSE STRATIFIED BY AGE (2013/14 DATA)

Variable	All ages	Over 18yrs	Under 18yrs
SMR [a]	0.016**	0.019**	0.008**
	[0.001]	[0.001]	[0.001]
IMD Crime	0.410**	0.492**	0.278**
	[0.026]	[0.030]	[0.049]
Population turnover [b]	0.005**	0.005**	0.005**
	[0.001]	[0.001]	[0.001]
Proportion white British	0.828**	0.516**	1.091**
	[0.100]	[0.127]	[0.197]
Proportion male	4.233**	7.034**	1.898
	[0.891]	[1.114]	[1.606]
IMD Income	0.723**	0.871**	-0.241
	[0.130]	[0.158]	[0.284]
IMD Environment	0.003**	0.004**	0.003
	[0.001]	[0.001]	[0.002]
Proportion of GP prescribing	-0.601**	-0.686**	0.045
	[0.050]	[0.059]	[0.124]
Distance to nearest service [c]	-0.011**	-0.012**	-0.007
	[0.002]	[0.003]	[0.005]
Mean waiting time	0.001	0.001	-0.005
	[0.001]	[0.001]	[0.003]
Constant	-3.856	-5.155	-1.977
	[0.481]	[0.597]	0.828
Number of areas [d]	9366	9279	8706
Adj R-squared	0.513	0.526	0.169

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. [d] Number of areas differs due to the removal of areas with very low populations. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

Table 18 highlights that the removal of the under-18s from the all-age group reduces the predictive power of the alcohol model slightly (from an adjusted R-squared of 0.334 in the all-age group to 0.327 in the over-18s group). The all-age model performs less well with the under-18s group with an adjusted R-squared of 0.160. Variables which are significant predictors of the over-18s group are not significant in the under-18s (SMR, IMD Environment, proportion male, proportion GP prescribing and distance to nearest service). Mean waiting time is not significant in the over-18s but is in the under-18s.

The under-18 age group are more likely to be characterised by class B[6] drug misuse, namely cannabis, compared with greater class A[6] drug misuse, particularly opiates and crack cocaine, in the adult group; this pattern may be associated with different predictors. We therefore investigated the younger age group further to determine whether a better-performing drugs and alcohol model was attainable but we were unable to improve on the adjusted R-squared of 0.232. The use of proportion in full-time higher education did not improve the model.

TABLE 18 DRUGS AND ALCOHOL: REGRESSION MODELS: ALCOHOL MISUSE STRATIFIED BY AGE (2013/14 DATA)

Variable	All ages	Over 18yrs	Under 18yrs
SMR [a]	0.011**	0.010**	0.002
	[0.001]	[0.001]	[0.001]
IMD Crime	0.273**	0.274**	0.240**
	[0.030]	[0.028]	[0.047]
Population turnover [b]	0.007**	0.003**	0.004**
	[0.001]	[0.001]	[0.001]
IMD Mood & Anxiety	0.128**	0.120**	0.093*
	[0.022]	[0.021]	[0.041]
Proportion male	3.953**	3.809**	2.329
	[1.095]	[1.001]	[1.408]
Proportion white British	0.669**	0.486**	0.994**
	[0.108]	[0.104]	[0.171]
IMD Environment	0.004**	0.004**	-0.0001
	[0.001]	[0.001]	[0.002]
Proportion of GP prescribing	-0.233**	-0.221**	0.226
	[0.063]	[0.057]	[0.138]
Distance to nearest service [c]	-0.007*	-0.007*	-0.008
	[0.003]	[0.003]	[0.005]
Mean waiting time	-0.003*	-0.002	-0.008**
	[0.001]	[0.001]	[0.002]
Constant	-3.098	-2.664	-1.768
	[0.580]	[0.529]	[0.748]
Number of areas [d]	9366	9279	8706
Adjusted R-squared	0.334	0.327	0.160

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Inflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. [d] Number of areas differs due to the removal of areas with very low populations. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

[6] Misuse of Drugs Act (1971)

MODEL 3. PERSON-BASED MODEL

A person-based model incorporated measures of past-treatment utilisation (days of treatment received during the previous year, whether treatment was completed and whether the individual had received prescription-based therapy during the previous year) on the prediction of 2013/14 expenditure at the level of the individual, alongside area-level needs variables.

Tables 19, 20 and 21 present person-based models for drug and alcohol misuse combined, drug misuse and alcohol misuse, respectively.

The best-performing predictors in all three models are received prescribing in the past year, days treated in the past year and whether treatment was completed in the previous year. These three variables together explain 46.9% of the variance in expenditure in the drug and alcohol misuse combined model, 48.8% in the drugs misuse model and a much lower figure, 2.1%, in the alcohol misuse model. The addition of other needs variables (SMR, population turnover and proportion male) does not add substantially to the adjusted R-squared statistic in any of the three models.

Impact on the needs index

Table 22 presents correlations between the needs indices obtained from individual models.

TABLE 19 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE. PERSON-BASED (2013/14 DATA)

Variable	i	ii	iii	iv	v	vi	vii	viii	ix
Days of treatment previous year (12/13)	12.608	13.193	10.311	10.309	10.309	10.309	10.320	10.320	10.320**
	[0.030]	[0.031]	[0.042]	[0.042]	[0.042]	[0.042]	[0.042]	[0.042]	[0.042]
Completed treatment previous year (12/13)		-1479.288	-1640.836	-1641.056	-1641.041	-1641.030	-1644.971	-1644.973	-1644.973**
		[6.010]	[6.475]	[6.474]	[6.474]	[6.474]	[6.527]	[6.527]	[6.527]
Received prescribing previous year (12/13)			1316.236	1315.976	1315.929	1315.905	1319.243	1319.247	1319.247**
			[13.569]	[13.569]	[13.569]	[13.569]	[13.658]	[13.658]	[13.658]
SMR [a]				0.068	0.051	0.051	0.048	0.047	0.047**
				[0.002]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Population turnover [b]					0.036	0.031	0.028	0.026	0.026**
					[0.002]	[0.002]	[0.002]	[0.003]	[0.003]
Proportion male						25.918	29.850	30.036	30.052**
						[3.856]	[4.262]	[4.259]	[4.257]
Proportion of GP prescribing							-8.665	-8.557	-8.551**
							[0.351]	[0.351]	[0.351]
Distance to nearest service [c]								-0.058	-0.057**
								[0.012]	[0.012]
Mean waiting time									-0.008
									[0.009]
Age Group 2 (15-19)	-1.570	0.034	1.060	1.082	0.968	0.964	0.986	0.989	0.989**
	[0.108]	[0.101]	[0.101]	[0.106]	[0.108]	[0.108]	[0.113]	[0.113]	[0.113]
Age Group 3 (20-24)	0.522	1.509	1.111	0.968	0.643	0.589	0.637	0.639	0.640**
	[0.135]	[0.135]	[0.135]	[0.140]	[0.140]	[0.141]	[0.146]	[0.146]	[0.146]
Age Group 4 (25-29)	4.682	5.550	4.297	4.144	4.007	3.951	4.042	4.037	4.037**
	[0.188]	[0.194]	[0.187]	[0.190]	[0.191]	[0.191]	[0.197]	[0.197]	[0.197]
Age Group 5 (30-44)	9.623	9.882	8.142	8.180	8.138	8.115	8.373	8.371	8.371**
	[0.171]	[0.179]	[0.165]	[0.168]	[0.169]	[0.169]	[0.177]	[0.177]	[0.177]
Age Group 6 (45-59)	2.838	3.022	2.360	2.538	2.556	2.552	2.635	2.638	2.638**
	[0.113]	[0.116]	[0.114]	[0.118]	[0.119]	[0.119]	[0.125]	[0.125]	[0.125]

Age Group 7 (60-64)	0.467	0.228	-0.210	0.048	0.088	0.092	0.097	0.105	0.106
	[0.104]	[0.104]	[0.103]	[0.107]	[0.108]	[0.108]	[0.114]	[0.114]	[0.114]
Age Group 8 (65+)	0.320	-0.238	-0.653	-0.398	-0.354	-0.332	-0.352	-0.345	-0.344**
	[0.076]	[0.077]	[0.077]	[0.081]	[0.082]	[0.083]	[0.088]	[0.088]	[0.088]
Constant	-0.401	0.343	0.734	-6.376	-7.493	-19.811	-20.604	-20.217	-20.162
	[0.056]	[0.055]	[0.056]	[0.257]	[0.277]	[1.907]	[2.097]	[2.101]	[2.104]
Number of observations[7]	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707
Adjusted R-squared	0.432	0.452	0.469	0.469	0.469	0.469	0.470	0.470	0.470

Notes: * $p < 0.05$. ** $p < 0.01$. Reference category is age group 1 (under 15). [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is drug and alcohol misuse expenditure for 2013/14. Unit of observation is the individual. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

[7] Excludes cases with known treatment but unknown area of residence

TABLE 20 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG MISUSE. PERSON-BASED (2013/14 DATA)

Variable	i	ii	iii	iv	v	vi	vii	viii	ix
Days of treatment previous year (12/13)	11.632	12.172	8.758	8.756	8.756	8.756	8.772	8.772	8.772**
	[0.030]	[0.031]	[0.038]	[0.038]	[0.038]	[0.038]	[0.038]	[0.038]	[0.038]
Completed treatment previous year (12/13)		-1366.504	-1557.942	-1558.068	-1558.058	-1558.051	-1562.268	-1562.269	-1562.269**
		[5.512]	[6.147]	[6.146]	[6.146]	[6.146]	[6.194]	[6.194]	[6.194]
Received prescribing previous year (12/13)			1559.761	1559.612	1559.582	1559.565	1562.734	1562.737	1562.737**
			[12.324]	[12.324]	[12.324]	[12.324]	[12.404]	[12.404]	[12.404]
SMR [a]				0.039	0.028	0.028	0.026	0.025	0.025**
				[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Population turnover [b]					0.023	0.020	0.018	0.016	0.016**
					[0.002]	[0.002]	[0.002]	[0.003]	[0.003]
Proportion male						17.584	19.693	19.816	19.821**
						[3.142]	[3.481]	[3.480]	[3.480]
Proportion of GP prescribing							-7.948	-7.876	-7.879**
							[0.333]	[0.333]	[0.333]
Distance to nearest service [c]								-0.039	-0.039**
								[0.010]	[0.010]
Mean waiting time									0.002
									[0.005]
Age Group 2 (15-19)	-1.801	-0.319	0.897	0.909	0.835	0.832	0.853	0.855	0.854**
	[0.107]	[0.098]	[0.098]	[0.100]	[0.100]	[0.100]	[0.105]	[0.105]	[0.105]
Age Group 3 (20-24)	0.213	1.124	0.652	0.570	0.359	0.323	0.354	0.355	0.355*
	[0.136]	[0.132]	[0.134]	[0.136]	[0.132]	[0.132]	[0.138]	[0.138]	[0.138]
Age Group 4 (25-29)	3.759	4.561	3.076	2.988	2.899	2.861	2.930	2.927	2.927**
	[0.175]	[0.179]	[0.171]	[0.172]	[0.173]	[0.173]	[0.179]	[0.179]	[0.179]
Age Group 5 (30-44)	6.956	7.195	5.133	5.154	5.128	5.112	5.287	5.286	5.286**
	[0.141]	[0.147]	[0.132]	[0.134]	[0.134]	[0.134]	[0.141]	[0.141]	[0.141]
Age Group 6 (45-59)	-0.994	-0.824	-1.608	-1.506	-1.494	-1.497	-1.541	-1.539	-1.539**
	[0.100]	[0.097]	[0.097]	[0.098]	[0.099]	[0.099]	[0.105]	[0.105]	[0.105]

Age Group 7 (60-64)	-0.959	-1.180	-1.698	-1.550	-1.524	-1.521	-1.560	-1.555	-1.555**
	[0.092]	[0.090]	[0.089]	[0.091]	[0.091]	[0.091]	[0.097]	[0.097]	[0.097]
Age Group 8 (65+)	-0.031	-0.546	-1.039	-0.892	-0.864	-0.849	-0.871	-0.867	-0.867**
	[0.074]	[0.073]	[0.074]	[0.076]	[0.077]	[0.077]	[0.082]	[0.082]	[0.082]
Constant	-0.494	0.193	0.657	-3.427	-4.152	-12.509	-12.499	-12.244	-12.258
	[0.055]	[0.054]	[0.055]	[0.215]	[0.234]	[1.554]	[1.711]	[1.715]	[1.716]
Number of observations[8]	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707
Adjusted R-squared	0.440	0.461	0.488	0.488	0.488	0.488	0.490	0.490	0.490

Notes: * $p < 0.05$. ** $p < 0.01$. Reference category is age group 1 (under 15). [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is drug and alcohol misuse expenditure for 2013/14. Unit of observation is the individual. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

[8] Excludes cases with known treatment but unknown area of residence

TABLE 21 DRUGS AND ALCOHOL: REGRESSION MODELS: ALCOHOL MISUSE. PERSON-BASED (2013/14 DATA)

Variable	i	ii	Iii	iv	v	vi	vii	viii	ix
Days of treatment previous year (12/13)	0.976	1.021	1.554	1.553	1.553	1.553	1.548	1.548	1.548**
	[0.012]	[0.013]	[0.025]	[0.025]	[0.025]	[0.025]	0.025	[0.025]	[0.025]
Completed treatment previous year (12/13)		-112.783	-82.894	-82.988	-82.983	-82.980	-82.703	-82.704	-82.705**
		[2.150]	[2.258]	[2.258]	[2.258]	[2.258]	2.281	[2.281]	[2.281]
Received prescribing previous year (12/13)			-243.525	-243.636	-243.652	-243.660	-243.491	-243.490	-243.489**
			[7.844]	[7.845]	[7.845]	[7.845]	7.899	[7.899]	[7.899]
SMR [a]				0.029	0.024	0.023	0.023	0.023	0.022**
				[0.001]	[0.001]	[0.001]	0.001	[0.001]	[0.001]
Population turnover [b]					0.014	0.013	0.013	0.012	0.012**
					[0.002]	[0.002]	0.002	[0.002]	[0.002]
Proportion male						8.205	9.951	9.956	10.022**
						[2.027]	2.216	2.215	2.214
Proportion of GP prescribing							-0.720	-0.686	-0.682**
							0.156	0.156	0.156
Distance to nearest service [c]								-0.018	-0.017**
								[0.006]	[0.006]
Mean waiting time									-0.007*
									[0.003]
Age Group 2 (15-19)	0.231	0.353	0.163	0.172	0.122	0.121	0.123	0.123	0.123**
	[0.033]	[0.033]	[0.034]	[0.036]	[0.038]	[0.038]	0.039	[0.039]	[0.039]
Age Group 3 (20-24)	0.309	0.385	0.458	0.398	0.263	0.245	0.261	0.261	0.261**
	[0.046]	[0.047]	[0.047]	[0.049]	[0.052]	[0.053]	0.054	[0.054]	[0.054]
Age Group 4 (25-29)	0.923	0.989	1.221	1.155	1.097	1.078	1.100	1.099	1.099**
	[0.071]	[0.072]	[0.073]	[0.074]	[0.074]	[0.075]	0.076	[0.076]	[0.076]
Age Group 5 (30-44)	2.667	2.687	3.009	3.025	3.005	2.997	3.080	3.079	3.079**
	[0.066]	[0.066]	[0.068]	[0.069]	[0.069]	[0.069]	0.072	[0.072]	[0.072]
Age Group 6 (45-59)	3.832	3.846	3.968	4.044	4.046	4.046	4.172	4.174	4.174**
	[0.075]	[0.076]	[0.077]	[0.078]	[0.078]	[0.078]	0.082	[0.082]	[0.082]

Age Group 7 (60-64)	1.426	1.408	1.489	1.598	1.607	1.609	1.653	1.656	1.656**
	[0.067]	[0.067]	[0.067]	[0.069]	[0.069]	[0.069]	0.072	[0.072]	[0.072]
Age Group 8 (65+)	0.351	0.309	0.386	0.494	0.502	0.510	0.513	0.515	0.515**
	[0.028]	[0.028]	[0.029]	[0.031]	[0.031]	[0.031]	0.033	[0.033]	[0.033]
Constant	0.093	0.150	0.077	-2.950	-3.545	-7.438	-8.208	-8.059	-8.031
	[0.017]	[0.017]	[0.017]	[0.130]	[0.150]	[0.994]	1.082	[1.084]	[1.085]
Number of observations[9]	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707	53,085,707
Adjusted R-squared	0.017	0.018	0.021	0.021	0.021	0.021	0.021	0.021	0.021

Notes: * $p < 0.05$. ** $p < 0.01$. Reference category is age group 1 (under 15). [a] Standardised Mortality Ratio. [b] Inflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is drug and alcohol misuse expenditure for 2013/14. Unit of observation is the individual. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

[9] Excludes cases with known treatment but unknown area of residence

TABLE 22 DRUGS AND ALCOHOL: CORRELATION BETWEEN THE NEEDS INDEX FOR EACH OF THE MODELS. 2013/14 DATA

	Model 1: SMR-only	**Model 1: drugs & alcohol**	**Model 1: drugs**	**Model 1: alcohol**	**Model 2 (>18): drugs & alcohol**	**Model 2 (<18): drugs & alcohol**	**Model 3 person-based: drugs & alcohol**
Model 1: SMR-only drug & alcohol misuse	1.000						
Model 1: age standardised drug & alcohol misuse	0.9427	1.000					
Model 1: age standardised drug misuse	0.9421	0.9997	1.000				
Model 1: age standardised alcohol misuse	0.9314	0.9747	0.9704	1.000			
Model 2: age stratified (over 18) drug & alcohol misuse	0.9568	0.9872	0.9863	0.9644	1.000		
Model 2: age stratified (under 18) drug & alcohol misuse	0.7495	0.7726	0.7604	0.8525	0.7830	1.000	
Model 3: person-based drug & alcohol misuse	0.7378	0.6997	0.6937	0.7423	0.7213	0.6688	1.000

SEXUAL HEALTH SERVICES FORMULA

This chapter discusses the data sources, methods for costing, and econometric applications used to generate weights for the sexual health component of the formula for the Public Health budget for England.

BACKGROUND

The existing formula for sexual health proxies the relative need across populations by applying national age-gender rates of STI diagnoses at GUM and community services, and MSOA rates of SMR<75 (see Department of Health (2012)). There are several problematic assumptions contained within the existing formula:

- that the same risk factors for STI diagnoses apply for similar age-gender groups between Local Authorities
- that resource intensity is identical for each STI
- that in addition to age and gender, only differences in SMR<75 identify variations in relative need for sexual health services

We propose an approach using utilisation data that addresses each of these assumptions with the aim to better identify the relative need for sexual health services between Local Authorities. Utilisation methods are useful in generating weights that identify need conditional on potential confounding influences. It is also attractive since it enables a smaller level of geographic analysis than epidemiological approaches where robust accurate data on health state at lower level/micro geography is not available. The utilisation approach has concerns, in particular, supply side effects and unmet need. However, some supply-side factors can be identified in the analysis and used to ensure that, as best possible, these effects are sterilised from the calculation of weighted populations.

The proposed approach makes several advances on the existing formula:

- The methods proposed cost sexual health utilisation in accordance to those proposed by Pathway Analytics (Pathway Analytics, 2013). This improves the existing formula as it enables the formula to account for relative differences in resource costs for different types of sexual health service activity.
- In employing the utilisation approach, the need weights are empirically derived from population data, providing guidance on the relative impact of each needs variable. This contrasts with the current formula whereby each prevalence rate is given the same weighting.
- The ability to identify need accurately is paramount for resource allocation. The smaller the geographic population of study, the more accurate the level of observed need (the ecological fallacy argument explains how need may be less precisely identified the larger an

area under study). LSOA is recorded in sexual health activity data, enabling a smaller geographic analysis of need. This improves the current formula which applies national prevalence rates and MSOA level SMRs.

- In addition, we propose estimating a person-based approach. Compared to LSOA level analysis, this improves the identification of need for local areas and accounts for persistence in patient utilisation of sexual health services.
- The proxies for need in the current formula are limited to national age and gender prevalence and MSOA SMR. We extend the proxies of need by conducting analysis of utilisation on a range of additional needs factors. The factors considered include those identified as risk factors by Public Health England, and factors highlighted for future consideration in the generation of the current public health formula (including deprivation, a point raised for further investigation by ACRA (ACRA, 2012)).
- Finally, our estimates are based on more recent data (2013-14 activity data).

ACTIVITY DATA

Activity data for GUM clinics was obtained via the Genitourinary Medicine Clinic Activity Data Set version 2 (GUMCADv2). GUMCADv2 contains diagnoses made, and services provided by GUM clinics (Level 3) and other commissioned (non–GUM) sexual health services (Level 2, includes enhanced General Practices, sexual and reproductive health services, young people's services, and others e.g. the Terrence Higgins Trust, outreach programmes, abortion centres) (Public Health England, 2013b).

GUMCADv2 is a mandatory dataset (all Level 2 and Level 3 commissioned sexual health care is to be reported to Public Health England since January 2012), with four (quarterly) extracts per calendar year. Data contains pseudo-anonymised patient level data. The mandatory reporting of Level 2 sexual health services in GUMCADv2 reflects recent initiatives to expand access to sexual health care and reduce sexually transmitted infections through provision of sexual health services in a primary and community care setting. GUMCADv2 therefore aims to capture all data on sexually transmitted infection tests, vaccinations, diagnoses and management across all Level 3 commissioned sexual health services. Data on Level 2 commissioned sexual health services are still being validated. During January 2012 to December 2013 only 45% of Level 2 services had submitted at least one GUMCADv2 data extract. Coverage varied geographically and by service type (75/375 GP providers); 209/289 sexual and reproductive health service providers; 27/32 young person’s services; and 17/35 other providers). Reported data has poor reporting of sexual orientation and country of birth. Preliminary analysis by the GUMCADv2 data holders suggest Level 2 services lead to an increase in HIV diagnoses of 2%, syphilis diagnoses 3%, gonorrhoea diagnoses 6%, chlamydia diagnoses 15% and full screens 10% (unpublished and preliminary finding from GUMCADv2).

The Sexual and Reproductive Health Activity Dataset (SRHAD) complements GUMCADv2. SRHAD includes data on sexual health and reproductive services provided in the community (Health and Social Care Information Centre, 2014a). Reporting of sexual and reproductive activity via SRHAD has been mandatory since 1st April 2014. Prior to this the KT31 (Community Contraceptive Services Collection) process of data entry was possible, though KT31 does not contain information on each patient’s Lower Super Output Area (LSOA) of residence, a key variable for the generation of the resource allocation formula. The data quality reports (Health and Social Care Information Centre, 2014b) state that 14/147 providers reported data via KT31 in 2013/14 (6.4% of reported activity), a further 10 gave incomplete data (mixtures of KT31/SRHAD over quarters, or merged or closed). Reporting via KT31 was unequally distributed across England, of all KT31 reports, 44% were from Yorkshire & Humber, and 34% from the East of England.

The Chlamydia Testing Activity Dataset (CTAD) contains all (GUM and non-GUM clinic) chlamydia testing conducted in England. The latest data for 2013 (Public Health England, 2014) shows the number of new chlamydia diagnoses reported in GUM clinics account for approximately 48% of all new chlamydia diagnoses in England. Chlamydia diagnoses in the community is relatively more likely for females (60% compared to 39% for males). Of all chlamydia tests conducted in England in 2013, 37% were conducted at GUM clinics (56% of male tests and 29% of female tests). The Public Health Outcome Framework for 2013-16 recommends a minimum level of 2,300 chlamydia tests per 100,000 for 15-24 year olds.

For the purposes of the formula, the most complete approach would be to match GUMCADv2, SHRAD, and CTAD at the patient level. This would give the total sexual health services used by each individual in England. However, this is not possible since each dataset contains a dataset-specific person identifier meaning matching at an individual patient level is not possible.

The quality of the SRHAD dataset is problematic for 2013/14 activity due to the migration of reporting from KT31 to SRHAD. The proportion of reported activity recorded by KT31 and the geographical spread of reporting differences mean that SRHAD analysis would be based on an unrepresentative dataset. Excluding SRHAD data from the analysis will be problematic if sexual and reproductive health services were not correlated with sexually transmitted infection activity.

We model three data specifications (the methods are detailed under the 'Model specifications' section):

1. Person-based – using GUMCADv2
2. Person-based – using GUMCADv2 and CTAD
3. Analysis at the LSOA-age-gender level – using GUMCADv2 and CTAD

Data specifications

LSOA specifications in GUMCADv2 and CTAD

LSOA (LSOA) is based on the patient's postcode. Any incorrect postcodes are coded 'X99999999'. Patients can change LSOA through the financial year. Patients who migrate between LSOA's can thus be observed over numerous LSOA's in a financial year. We assign each patient with their first reported LSOA in a financial year. Note that the patients residential LSOA is modelled and not the LSOA of the health care provider.

Both CTAD and GUMCADv2 record LSOA of the patient's residence using the 2001 LSOA code specification. Since our measures for need will be largely from 2011 LSOA specifications, 2001 LSOAs are matched to the 2011 respective LSOA. There are four possible outcomes:

i. There is no change in LSOA
ii. The LSOA is split
iii. The LSOA is merged

iv. The LSOA is fragmented in a way such that mapping is not possible for a mutually exclusive 1:1 relationship

In both datasets we map LSOAs accordingly: for (i) we replace the reported 2001 LSOA code with the 2011 LSOA code. For (ii) we duplicate costs (either at person-level or LSOA, age, gender level) and apportion activity by the number of splits. For (iii) we replace the reported 2001 LSOA code with the new 2011 LSOA code. For (iv) we cannot make any justifiable assumptions to apportion activity and as such these costs/activity are excluded from the analysis. Our analysis is made on 32,702 LSOA since 142 are excluded due to (iv). See Table A6 for those LSOAs excluded from the analysis.

Data cleaning

Where data are missing, we apportion costs based on average shares in England:

- Where age is missing but LSOA and gender are present, we apportion costs by the age distribution of the recorded gender in the recorded LSOA population
- Where gender is missing but LSOA and age are present, we apportion costs by the gender distribution of the recorded age in the recorded LSOA population
- Where LSOA or age and gender are missing, we apportion cost to each LSOA's respective age and gender size.

Total budget to cost

The sexual health spend for 2013-14 was £645,089,000[10], and accounted for 25.68% of public health expenditure (£2.5bn). This covers services provided by GUM clinics, and sexual health services provided outside of GUM clinics. The costs for activity we observe in GUMCADv2 and CTAD are for service codes 61 (sexual health services – STI testing and treatment (prescribed functions)), this covers £382,455,000 (59.28%) of total expenditure on sexual health services by LAs in 2013/14. Activity code 62 (Sexual health services – contraception (prescribed functions) – 27.70%) would be captured in SRHAD. Activity code 63 (Sexual health services – advice, prevention and promotion (non-prescribed functions) – 13.01%) is not recorded in activity datasets.

ACTIVITY IN GUMCADV2

A patient can use multiple services and have multiple diagnoses represented by multiple rows of data in the dataset. We restructure the data so each patient has one row, where treatment for respective services and diagnoses is assumed to have occurred. This is done by generating flags for each diagnoses/activity across each row and finally summing all activity and collapsing the data at individual level. Age is recorded at the first attendance.

[10] https://www.gov.uk/government/statistics/local-authority-revenue-expenditure-and-financing-england-2013-to-2014-individual-local-authority-data

Activity is broken down into two types – diagnoses and activity/service received. In GUMCADv2, activity is recorded either as a Sexual Health and HIV Activity Property Type (SHHAPT) (previously KC60) or READ code (READ). READ codes are used by GPs and some Level 2 providers. Since Level 2 providers are not in the dataset, only SHAPPT codes are relevant for the analysis.

There were 4,667,842 rows of data in GUMCADv2 for the 2013-14 financial year (1,285,271 patients). The breakdown of clean SHAPPT codes is provided in Table 1. Since we aim to identify how to distribute the sexual health budgets to LAs within England, we remove those patients/activity where the patient has not reported a valid LSOA code within England and LSOA code 'X99999999' is not reported, this reduces the number of rows of data to 4,632,009 (1,276,560 patients) ('England' activity volumes and percentages in Table 23).

The dataset is cleaned prior to release and involves:

- De-duplication of events that are not feasible e.g. two tests stated where only one can be conducted within a set period
- Removing incompatible diagnoses or services

These services are contained in the 'XXXX' SHAPPT code.

TABLE 23 SEXUAL HEALTH: SHAPPT ACTIVITY IN GUMCADV2 2013/14

SHAPPT code	Activity	Frequency 2013/14	Percent	England Frequency 2013/14	England Percent
A1	Syphilis - primary	1,460	0.03	1,445	0.03
A2	Syphilis – secondary	925	0.02	919	0.02
A3	Syphilis – early latent	994	0.02	982	0.02
A4	Syphilis – cardiovascular	87	0.00	86	0.00
A5	Syphilis – neurosyphilis	60	0.00	60	0.00
A6	Syphilis – other late and latent	1,717	0.04	1,708	0.04
A7A	Syphilis – congenital	7	0.00	7	0.00
B	Gonorrhoea	30,467	0.65	30,237	0.65
C1	Chancroid	60	0.00	60	0.00
C10A	Genital herpes – first episode	32,576	0.70	32,312	0.70
C10B	Genital herpes – recurrent episode	27,007	0.58	26,831	0.58
C11A	Genital warts – first episode	72,931	1.56	72,247	1.56
C11D	Genital warts – recurrent episode	63,425	1.36	62,898	1.36
C12	Molluscum contagiosum	11,152	0.24	11,048	0.24
C13	Hepatitis B – first diagnosis	1,382	0.03	1,376	0.03
C14	Hepatitis C – first diagnosis	990	0.02	981	0.02
C15	Hepatitis A – first diagnosis	3	0.00	3	0.00
C2	LGV	489	0.01	486	0.01
C3	Donovanosis	36	0.00	35	0.00
C4	Chlamydia	103,190	2.21	102,302	2.21
C4N	Non-specific genital infection	53,905	1.15	53,464	1.15
C4X	Chlamydia – diagnosed elsewhere	10,195	0.22	10,126	0.22
C5A	PID	20,549	0.44	20,435	0.44
C5AB	PID/chlamydia	449	0.01	447	0.01
C5AC4	PID/gonorrhoea	2,118	0.05	2,108	0.05

C5B	Opthalmia neonatorum	1	0.00	1	0.00
C6A	Trichomoniasis	6,474	0.14	6,453	0.14
C6B	BV and anaerobic balantis	97,135	2.08	96,691	2.09
C6C	Balantis/vaginitis/vaginosis	22,318	0.48	22,106	0.48
C7	Candidosis	87,912	1.88	87,452	1.89
C8	Scabies	1,609	0.03	1,584	0.03
C9	Pediculosis pubis	655	0.01	650	0.01
D2A	Urinary Tract Infection	17,583	0.38	17,490	0.38
D2B	Other conditions requiring treatment	245,079	5.25	243,659	5.26
D3	No service/treatment required	603,291	12.92	598,456	12.92
H	HIV – known positive	19,619	0.42	19,502	0.42
H1	HIV – new diagnosis	2,782	0.06	2,753	0.06
H1A	HIV – new diagnosis, acute infection	293	0.00	292	0.00
H1B	HIV - new diagnosis, late infection	277	0.00	274	0.00
H1X	HIV – new diagnoses, diagnosed elsewhere	778	0.02	770	0.02
H2	Attendance for HIV related care	120,097	2.57	119,633	2.58
P1A	HIV test – antibody test	70,712	1.51	69,999	1.51
P1B	HIV test – offered and refused	313,118	6.71	310,528	6.70
P1C	HIV test – not appropriate	115,801	2.48	114,725	2.48
P2A	Hepatitis B – 1st dose	28,548	0.61	28,217	0.61
P2B	Hepatitis B – 2nd dose	20,333	0.44	20,135	0.43
P2C	Hepatitis B – 3rd dose	17,283	0.37	17,129	0.37
P2I	Hepatitis B – immune	17,393	0.37	17,193	0.37
P3	Contraception	135,510	2.90	134,852	2.91
P4	Cervical cytology done	21,901	0.47	21,803	0.47
P4A	Cervical cytology – minor	1,892	0.04	1,885	0.04
P4B	Cervical cytology – major	533	0.01	532	0.01
PEPS	PEPSE	6,938	0.15	6,873	0.15
PN	Partner notification - initiated	9,727	0.21	9,642	0.21
PNC	Partner notification – chlamydia	56,613	1.21	56,037	1.21
PNG	Partner notification – gonorrhoea	13,151	0.28	13,044	0.28
PNH	Partner notification – syphilis	2,137	0.05	2,117	0.05
PNS	Partner notification – HIV	1,954	0.04	1,944	0.04
SW	Sex worker	9,012	0.19	8,557	0.18
T1	STI test – chlamydia	6,179	0.13	6,121	0.13
T2	STI test – chlamydia and gonorrhoea	331,565	7.10	328,568	7.09
T3	STI test – chlamydia, gonorrhoea and syphilis	21,630	0.46	21,473	0.46
T4	STI test – chlamydia, gonorrhoea, syphilis and HIV	1,049,447	22.48	1,040,740	22.47
W1	HPV vaccination – 1st dose	183	0.00	181	0.00
W1Q	HPV vaccination – 1st dose, quadrivalent	141	0.00	141	0.00
W2	HPV vaccination – 2nd dose	76	0.00	76	0.00
W2Q	HPV vaccination – 2nd dose, quadrivalent	108	0.00	108	0.00
W3	HPV vaccination – 3rd dose	75	0.00	74	0.00
W3Q	HPV vaccination – 3rd dose, quadrivalent	86	0.00	86	0.00
XXXX		748,025	16.03	743,220	16.05
Z	Prisoner	5,694	0.12	5,640	0.12
Total		4,667,842	100.00	4,632,009	100.00

Individual matching, data not usually reported this way but presented since this disaggregation enables better costing of activity.

COSTING ACTIVITY

The first stage of the analysis is to cost all activity reported in GUMCADv2. Costing was conducted by applying the Integrated Sexual Health Tariff proposed by Pathway Analytics (Pathways Analytics, 2013). All activity recorded in GUMCADv2 has been requested to ensure, as accurately as possible, that we model actual expenditure on all Level 3 commissioned sexual health care. The tariff and matched GUMCADv2 activity (by SHHAPT) and SRHAD activity are provided in Table 24.

The tariff does not include the Market Forces Factor. These prices account for an average of a range of relevant services in similarly priced care pathways. The tariffs were calculated independently of clinicians and service providers. The primary tariff is for the activity delivered on its own. The additional tariff is the cost of delivering alongside another more expensive activity. These tariffs were implemented from April 2012.

We assign costs in accordance to the grouper provided by Pathway Analytics. This assigns each SHAPPT code with an activity code (Table 24), the corresponding activities are reported in Table 25. The grouper infers a cost for diagnoses reported in GUMCADv2. This is in comparison to GUMCADv2 reported tests which mainly cover chlamydia, gonorrhoea, syphilis, and HIV.

After removing those records where patients reside outside of England, and SHAPPT codes representing no cost; activity in GUMCADv2 total £159m, 3.3m activities, and 1.2m patients (Table 25). The mean cost per patient is £131.27. The lowest cost patient is £28.25 and the highest £2,137.75. We follow the GUMCADv2 extract groupings of age into <15, 16-19, 20-24, 25-34, 35-64, and 65+ (GUMCADv2 list ages <15 and 15 separately but here we group these ages together). Table 26 and Figures 6 and 7 give the total and average costs by age band and gender. The largest portion of costed activity comes from females (52.83% of all valid gender) but average costs are greater for males (£135 to £128 for females). The age group 25-34 have the largest share of costed activity. Whilst females have a higher total cost than males until age 25-34, the average cost for a female is lower from ages 20-24.

TABLE 24 SEXUAL HEALTH: ACTIVITY MATCHING OF THE INTEGRATED SEXUAL HEALTH TARIFF TO GUMCADV2

Integrated Sexual Health Tariff currency	Primary tariff (£)	Additional tariff (£)	GUMCADv2 activity code SHHAPT	Dataset captured	Activity code
STI intervention C	279.38	264.77	A1 A2 A3 A4 A5 A6 A7A C1 C3	GUMCADv2	1
SRH complex	211.95	185.20	P4B	1 GUMCADv2,	2

				SRHAD	
Medical gynaecology	127.99	111.60		SRHAD	3
Psycho sex/ counselling	129.95	119.67		SRHAD	4
LARC procedure	137.91	118.35		SRHAD	5
STI intervention B	114.82	86.40	B C11A C11D C12 C2 C5A C5AB C5B PEPS	GUMCADv2	6
T5 HSV test	82.85	75.82	C10A C10B	GUMCADv2	7
T4 Full screen	80.58	56.11	T4	GUMCADv2	8
TT 3 site chlamydia and gonorrhoea test	70.24	70.24		GUMCADv2	9
T6 Hepatitis test	67.90	61.01		GUMCADv2	10
T3 Chlamydia, gonorrhoea, syphilis tests	58.80	42.37	T3	GUMCADv2	11
SRH standard	57.22	31.03	P3	4 GUMCADv2, SRHAD	12
HIV test	51.85	28.14	PIA P4 P4A	GUMCADv2	13
T2 Chlamydia and gonorrhoea test	47.11	30.67	T1 T2	GUMCADv2	14
STI intervention A	28.25	20.73	C13 C14 C15 C4 C4N C4X C5AC4 C6A C7 C8 C9 D2A D2B D3 P2A P2B P2C W1 W1Q W2 W2Q W3 W3Q	GUMCADv2	15
Ultrasound	29.14	29.14		SRHAD	16
TS microscopy	14.93	14.93		GUMCADv2	17

Source: Pathway Analytics (2013)

TABLE 25 SEXUAL HEALTH: ACTIVITY AND COSTS IN GUMCADV2 2013/14

Activity code	Activity	Total cost (£)	Freq.	Freq. patients
1	STI intervention C	1,481,273	5,302	1,530
2	SRH complex	112,757	532	186
2.64	Partner notifications	0	82,784	22,436
6	STI intervention B	23,446,810	204,672	70,782
7	T5 HSV test	4,839,427	59,143	20,332
8	T4 Full screen	78,100,928	1,040,740	453,846
11	T3 Chlamydia, gonorrhoea, syphilis tests	1,104,852	21,473	7,946
12	SRH standard	6,873,611	158,540	58,663
13	HIV test	2,783,831	69,999	26,767
14	T2 Chlamydia and gonorrhoea test	12,659,694	334,689	128,903
15	STI intervention A	27,862,886	1,311,048	421,892
Total		159,266,069	3,288,922	1,213,283

TABLE 26 SEXUAL HEALTH: AVERAGE AND TOTAL COST BY AGE GROUP AND GENDER (PATIENTS IN GUMCADV2)

	Total cost (£)					Average cost (£)				
Age band	Not known	Male	Female	Not specified	Total	Not known	Male	Female	Not specified	Total
0-14	0	56,381	388,190	0	444,571	0	89	120	0	115
	0	636	3,223	0	3,859	0	636	3,223	0	3,859
15-19	1,761	5,645,146	13,867,278	396	19,514,581	104	131	135	79	134
	17	42,948	102,823	5	145,793	17	42,948	102,823	5	145,793
20-24	4,140	18,769,654	25,593,908	625	44,368,327	112	139	132	89	135
	37	134,722	194,109	7	328,875	37	134,722	194,109	7	328,875
25-34	6,375	28,313,346	28,507,262	1,359	56,828,342	120	136	126	105	131
	53	207,558	225,373	13	432,997	53	207,558	225,373	13	432,997
35-44	2,516	12,314,730	10,041,971	941	22,360,158	140	134	121	157	128
	18	91,596	82,978	6	174,598	18	91,596	82,978	6	174,598
45-64	1,944	8,848,867	5,648,050	826	14,499,687	150	129	117	103	124
	13	68,471	48,118	8	116,610	13	68,471	48,118	8	116,610
65-99	81	894,679	267,155	0	1,161,915	81	124	105	0	119
	1	7,192	2,542	0	9,735	1	7,192	2,542	0	9,735
Missing	0	50,137	38,352	0	88,489	0	116	100	0	108
	0	433	383	0	816	0	433	383	0	816
Total	16,817	74,892,940	84,352,166	4,147	159,266,070	121	135	128	106	131
	139	553,556	659,549	39	1,213,283	139	553,556	659,549	39	1,213,283

Costs rounded to nearest £, sample size reported below cost

FIGURE 6 SEXUAL HEALTH: TOTAL COST (GUMCADV2)

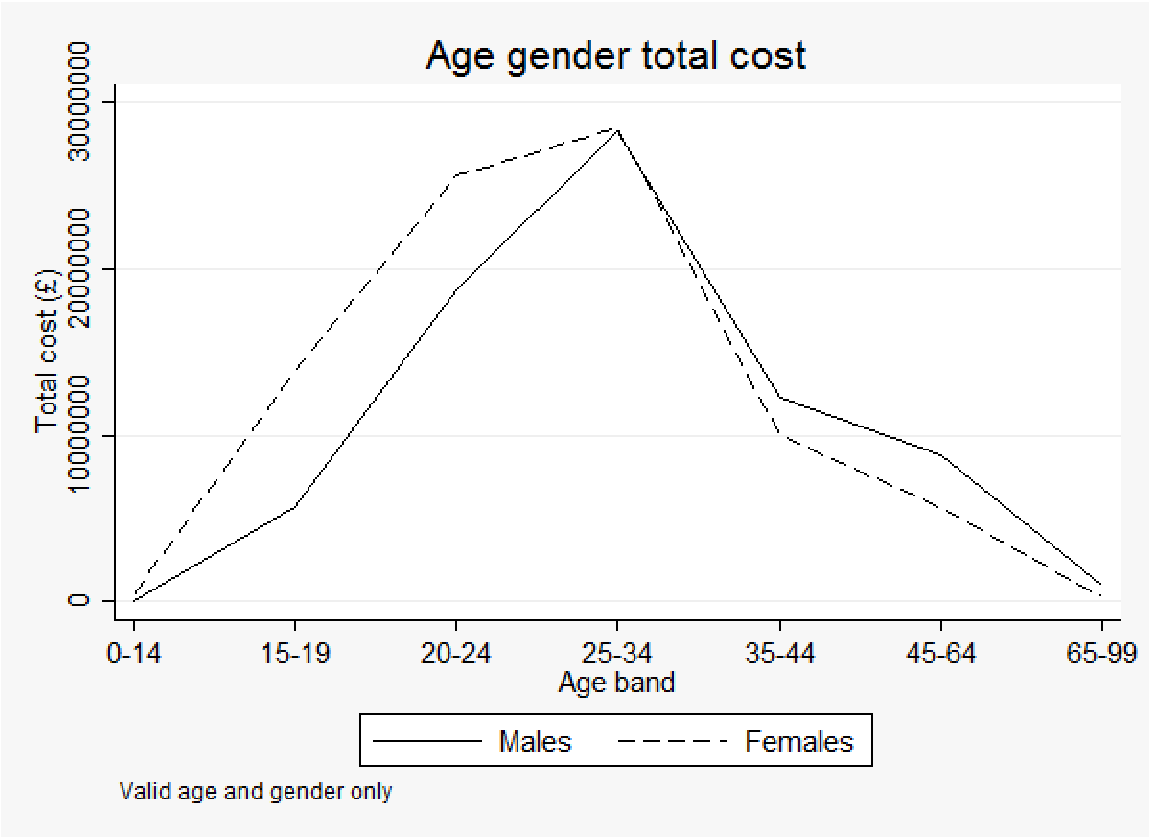
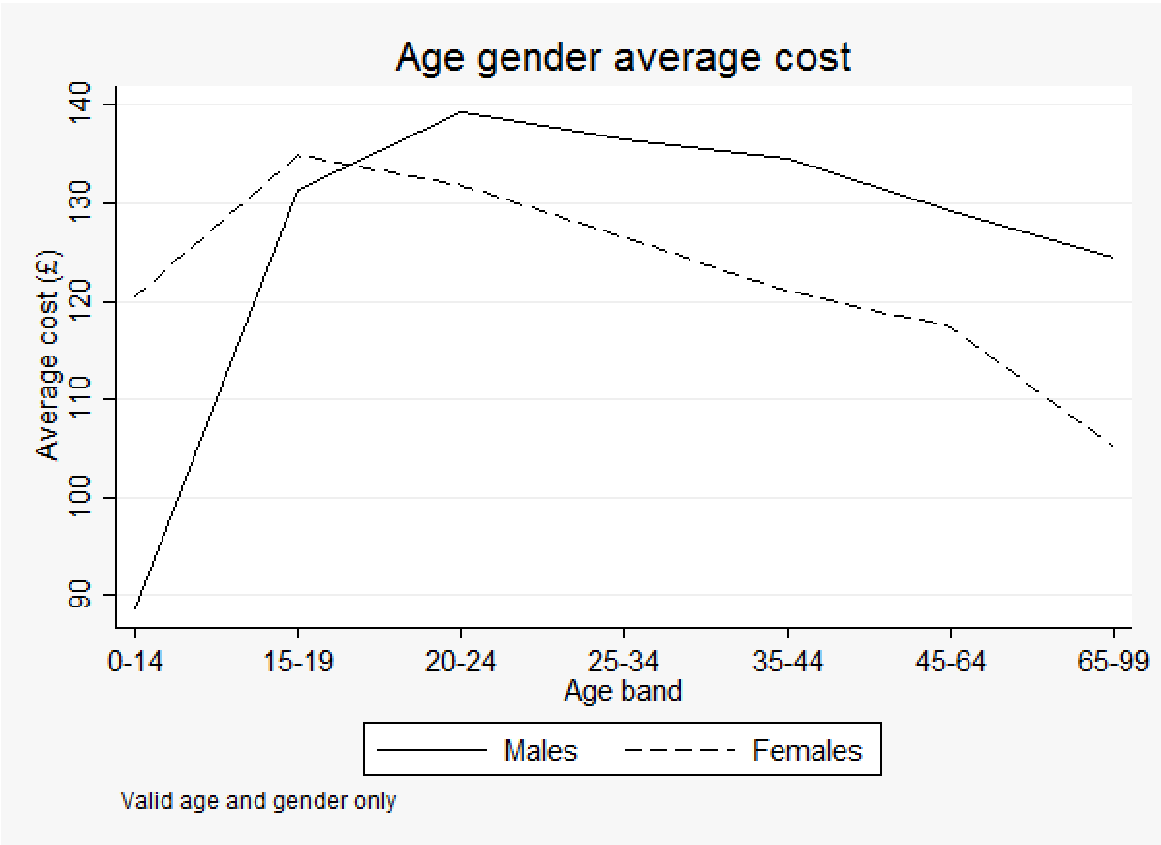


FIGURE 7 SEXUAL HEALTH: AVERAGE COST (GUMCADV2) (PATIENTS ONLY)



Removing fragmented LSOAs (see 'Data specifications', above), reduces the costed activity in GUMCADv2 to £154,097,895. Apportioning costs where LSOA, age, or gender are missing results in a final GUMCADv2 sample of 2,576,708 comprised of 383,636 patients who had recorded activity in GUMCADv2 for 2012-13 and 2013-14; 848,901 who had activity in 2012-13 but not 2013-14, 884,355 who had treatment in 2013-14 but not 2012-13, and 459,816 LSOA age and gender groups with zero activity in 2012-13 and 2013-14. 459,816 is greater than 457,828 (=32,702 (LSOA – excludes those not matched to 2001 LSOA) * 2 (gender) * 7 (age bands)) due to the necessary duplication of split LSOAs.

The mean cost was £59.80, smallest £0 and largest £2,137.75. Costs are greater for several age groups in the clean dataset due to the apportioning of costs by the age distribution of the LSOA where no age group is provided.

Table 27 and Figure 8 and 9 give the total and average costs by age band and gender. The largest portion of costed activity comes from females (53.05% of all valid gender). The age group 25-34 have the largest share of costed activity (35.34%).

TABLE 27 SEXUAL HEALTH: AVERAGE AND TOTAL COST BY AGE GROUP AND GENDER (CLEAN)

	Total cost (£)			Average cost (£)		
Age band	Male	Female		Male	Female	Total
0-14	340,761	645,034	985,795	2	9	6
	34,929	41,505	76,434	34,929	41,505	76,434
15-19	5,435,984	13,261,365	18,697,349	50	67	61
	105,888	197,027	302,915	105,888	197,027	302,915
20-24	17,892,838	24,418,694	42,311,532	65	67	66
	272,977	365,006	637,983	272,977	365,006	637,983
25-34	27,141,402	27,317,322	54,458,724	66	64	65
	407,937	422,179	830,116	407,937	422,179	830,116
35-44	11,680,063	9,737,827	21,417,890	58	53	56
	199,154	178,374	377,528	199,154	178,374	377,528
45-64	8,763,014	5,823,593	14,586,607	54	47	51
	153,965	115,328	269,293	153,965	115,328	269,293
65-99	1,097,969	542,029	1,639,998	19	7	14
	45,178	37,261	82,439	45,178	37,261	82,439
Total	72,352,031	81,745,864	154,097,895	58	59	59
	1,220,028	1,356,680	2,576,708	1,220,028	1,356,680	2,576,708

Costs rounded to nearest £, sample size reported below cost, average cost is per capita

FIGURE 8 SEXUAL HEALTH: TOTAL COST (GUMCADV2) (CLEAN)

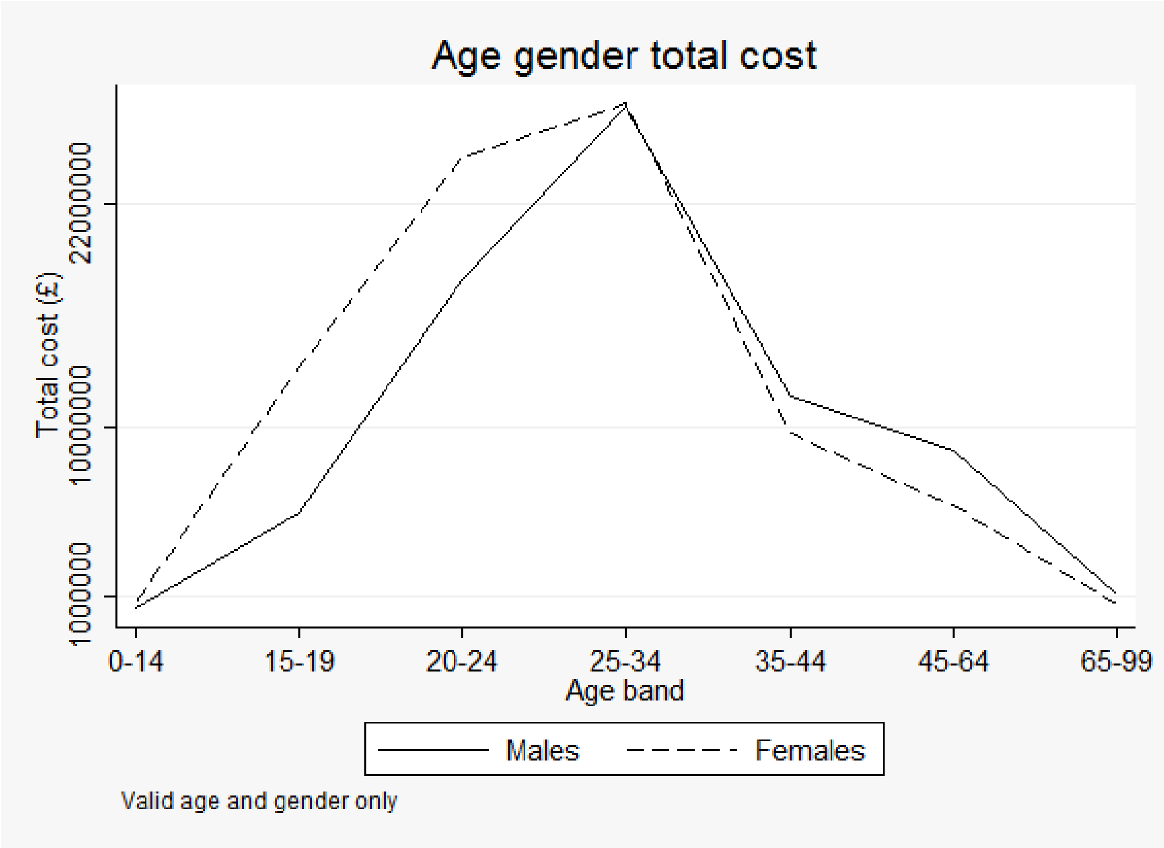
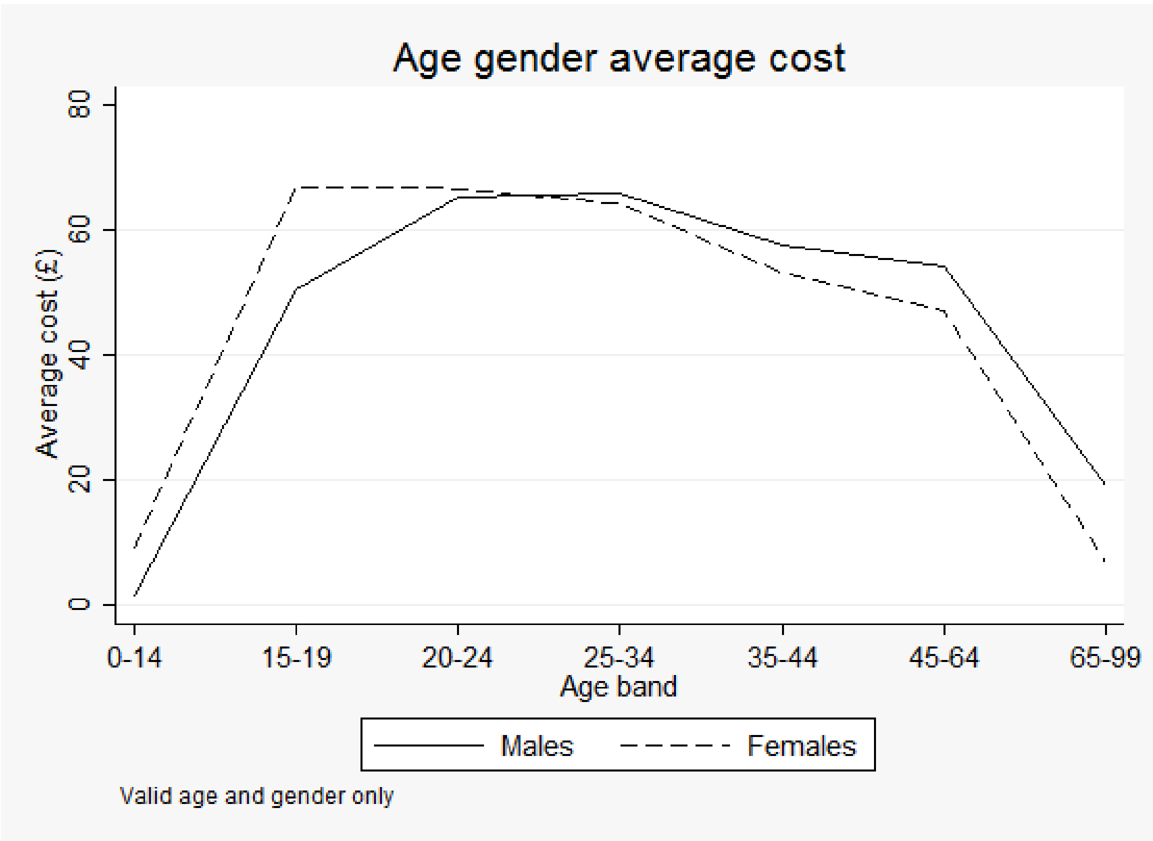


FIGURE 9 SEXUAL HEALTH: AVERAGE COSTED ACTIVITY (GUMCADV2) (CLEAN) (PATIENTS)



ACTIVITY IN CTAD

We model activity recorded in CTAD for the period 1st April 2013 to 31st March 2014. Data was provided at LSOA age and gender level. A total of 2,286,349 chlamydia tests were recorded in CTAD over the sample period. Applying the T1/T2 activity price of £47.11 (see Activity 14 in Table 25), results in a total spend of £108m (£107,709,905).

We follow the GUMCADv2 groupings of age into <15, 16-19, 20-24, 25-34, 35-64, and 65+ (GUMCADv2 list ages <15 and 15 separately but here we group these ages together). A total of 266,826 LSOA age gender observations are in the CTAD data using the above age grouping. Table 28 and Figure 10 give the total costs by age band and gender. The largest portion of costed activity comes from females (77.65% of all valid gender). The age group 20-24 have the largest share of costed activity.

Removing fragmented LSOAs (see 'Data specifications', above), reduces the costed activity in CTAD to £107,125,552. Apportioning costs where LSOA, age, or gender are missing results in a final CTAD sample of 457,828 (=32,702 (LSOA – excludes those not matched to 2001 LSOA) * 2 (gender) * 7 (age bands)). Table 29 and Figures 11 and 12 give the total and average costs by age band and gender. The largest portion of costed activity comes from females (77.18% of all valid gender). The age group 20-24 have the largest share of costed activity.

TABLE 28 SEXUAL HEALTH: TOTAL LSOA CTAD COSTED ACTIVITY BY AGE GROUP AND GENDER

	Total cost (£)				
Age band	Not known	Male	Female	Not specified	Total
0-14	15,169	165,026	676,924	377	857,496
	135	2,374	7,589	7	10,105
15-19	281,105	7,126,000	17,680,430	3,675	25,091,210
	1,699	25,068	31,500	49	58,316
20-24	365,950	8,149,748	22,641,348	5,182	31,162,228
	1,714	26,070	32,366	80	60,230
25-34	247,610	4,789,391	22,824,796	8,291	27,870,088
	1,149	16,719	32,190	149	50,207
35-44	91,865	2,011,079	12,347,390	2,497	14,452,831
	515	10,509	31,321	47	42,392
45-64	50,361	1,386,212	6,210,276	424	7,647,273
	236	8,572	28,653	4	37,465
65-99	2,497	137,750	265,182	47	405,476
	30	1,427	4,556	1	6,014
Missing	81,265	47,346	93,608	1,084	223,303
	200	658	1,236	3	2,097
Total	1,135,822	23,812,552	82,739,954	21,577	107,709,905
	5,678	91,397	169,411	340	266,826

Costs rounded to nearest £, sample size reported below cost

FIGURE 10 SEXUAL HEALTH: TOTAL COSTED ACTIVITY (CTAD)

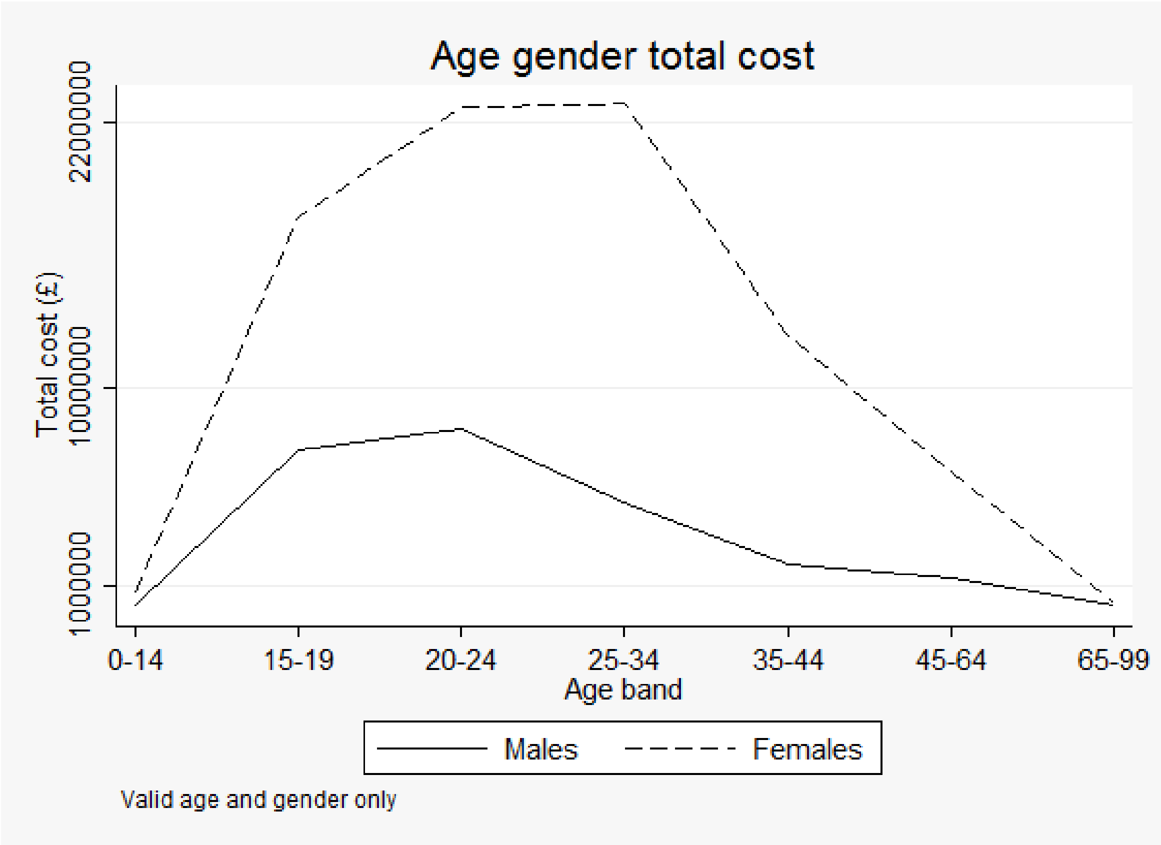


TABLE 29 SEXUAL HEALTH: TOTAL LSOA CTAD COSTED ACTIVITY BY AGE GROUP AND GENDER

	Total cost (£)			Ave cost (£)		
Age band	Male	Female	Total	Male	Female	Total
0-15	396,084	888,582	1,284,666	0	0	0
	32,702	32,702	65,404	32,702	32,702	65,404
16-19	7,202,648	17,533,186	24,735,834	4	11	8
	32,702	32,702	65,404	32,702	32,702	65,404
20-24	8,142,465	22,431,694	30,574,159	5	13	9
	32,702	32,702	65,404	32,702	32,702	65,404
25-34	4,728,890	22,581,296	27,310,186	1	6	4
	32,702	32,702	65,404	32,702	32,702	65,404
35-44	2,063,178	12,306,335	14,369,513	1	3	2
	32,702	32,702	65,404	32,702	32,702	65,404
45-64	1,606,087	6,442,216	8,048,303	0	1	1
	32,702	32,702	65,404	32,702	32,702	65,404
65-99	308,257	494,631	802,888	0	0	0
	32,702	32,702	65,404	32,702	32,702	65,404
Total	24,447,609	82,677,940	107,125,549	2	5	3
	228,914	228,914	457,828	228,914	228,914	457,828

Costs rounded to nearest £, sample size reported below cost, average cost is per capita

FIGURE 11 SEXUAL HEALTH: TOTAL COSTED ACTIVITY (LSOA, CTAD) (CLEAN)

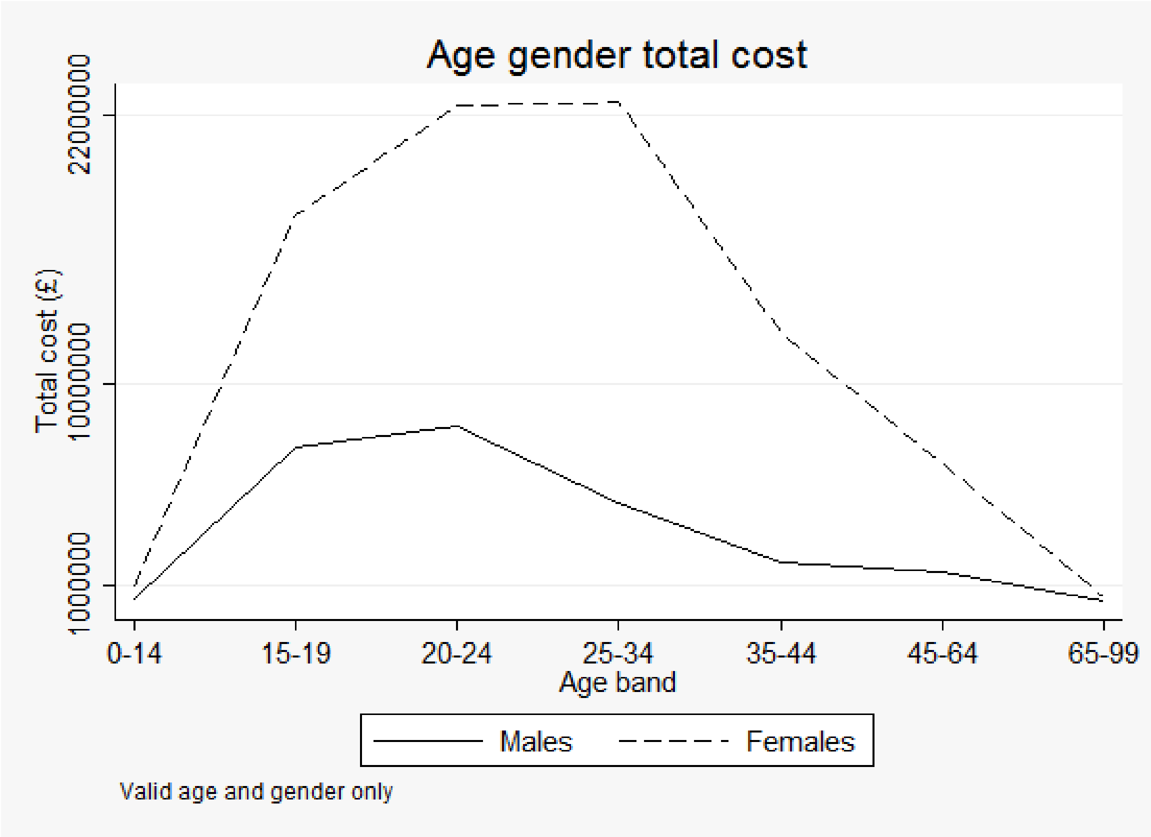
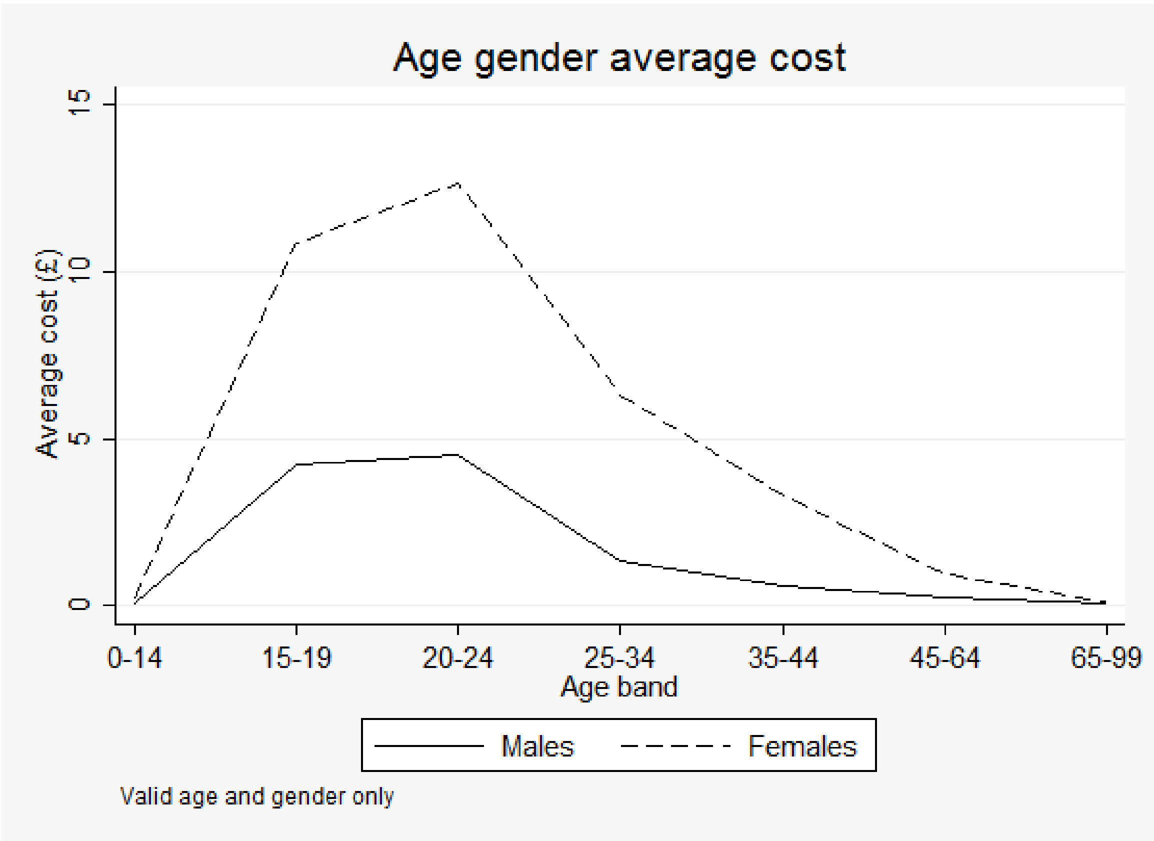


FIGURE 12 SEXUAL HEALTH: AVERAGE COSTED ACTIVITY (LSOA, CTAD) (CLEAN) (PER CAPITA)



MODELLING APPROACH

PERSON-BASED GUMCADV2

A person-based approach is possible using GUMCADv2 data. The person-based approach requires a number of restrictive assumptions:

1. Chlamydia activity observed in GUMCADv2 proxies accurately chlamydia testing and diagnoses in the community
2. That activity in GUMCADv2 proxies accurately with sexual and reproductive health services reported in SRHAD.

Activity and costs for the person-based GUMCADv2 are provided in Table 27 and Figures 8 and 9.

PERSON-BASED GUMCADV2 AND CTAD

An alternative to using only GUMCADv2 data is to match in, at the LSOA age and gender level, CTAD activity. First, all tests and activity involving chlamydia in GUMCADv2 are removed from costed activity. Second, costed activity in CTAD is apportioned on a per capita basis to each LSOA age and gender group. Since we cannot observe historic individual use at the LSOA age and gender level this is processed regardless of past use.

Chlamydia test in GUMCADv2 should form part of the chlamydia totals in CTAD. We initially merged in CTAD LSOA age gender chlamydia totals but found that the reported number of chlamydia tests in GUMCADv2 exceeded those reported in CTAD for the majority of LSOA age and gender groups. This is likely to be due to error reporting in LSOA (not known) within either dataset, or changing age over the calendar year. We are unable to 'net out' chlamydia testing in CTAD covered by GUMCADv2. This is unfortunate since the GUMCADv2 costed chlamydia tests vary (depending on whether additional gonorrhoea, syphilis or HIV tests were performed).

Removing all activity involving chlamydia testing/diagnoses results in a final costed activity value of £72,869,928 in GUMCADv2. This total differs from subtracting chlamydia activity costs in Table 25 because the removal of chlamydia tests makes most activities become the primary activity, inflating the respective costs.

Incorporating CTAD data on a per capita basis gives a total costed activity of £179,989,104. Total and average costs by age group and gender are provided in Table 30 and Figures 13 and 14 respectively.

The total costed activity varies from reported LA spend of £382,455,000 because Pathway Analytics is not the standard tariff charged by providers to LA's. A hospital tariff for first and follow-up attendance is in place. The costs are:

- First attendance – single professional: £136.00
- First Attendance – multi professional: £142.00
- Follow Up Attendance – single professional: £107.00
- Follow Up Attendance – multi professional: £107.00

These costs are larger than most costs under the Pathways Analytics tariff. The GUMCADv2 data contains a clean_first_attendance flag that identifies first and follow up attendances. Costing GUMCADv2 using this approach in the data gives a total spend in excess of £500m (there are over 4 million first and follow up attendances and without information on how clinics are charging LA's (for example, by merging activities into a single first attendance fee) we cannot identify the accurate charged attendances). This £500m does not include Level 2 services and chlamydia testing outside of GUM clinics. We are therefore confident that the costed activity modelled is not reflective of under recorded activity (though we do have no Level 2 services), and more a reflection of the tariff used.

TABLE 30 SEXUAL HEALTH: TOTAL LSOA CTAD COSTED AND GUMCADV2 ACTIVITY BY AGE GROUP AND GENDER

	Total cost (£)			**Ave cost (£)**		
Age band	Male	Female	Total	Male	Female	Total
0-15	613,587	1,609,149	2,222,736	2	13	8
	35,982	47,364	83,346	35,982	47,364	83,346
16-19	9,449,458	23,783,502	33,232,960	27	46	39
	104,567	190,919	295,486	104,567	190,919	295,486
20-24	16,184,536	33,870,520	50,055,056	34	44	40
	272,840	364,963	637,803	272,840	364,963	637,803
25-34	17,181,540	35,612,036	52,793,576	32	38	35
	407,694	422,081	829,775	407,694	422,081	829,775
35-44	7,722,958	17,069,582	24,792,540	29	30	30
	199,071	178,235	377,306	199,071	178,235	377,306
45-64	5,874,596	9,357,825	15,232,421	27	25	26
	153,866	115,152	269,018	153,866	115,152	269,018
65-99	867,312	792,507	1,659,819	10	4	8
	45,037	37,116	82,153	45,037	37,116	82,153
Total	57,893,987	122,095,121	179,989,108	29	37	33
	1,219,057	1,355,830	2,574,887	1,219,057	1,355,830	2,574,887

Costs rounded to nearest £, sample size reported below cost, average cost is per capita

FIGURE 13 SEXUAL HEALTH: TOTAL COSTED ACTIVITY (PERSON-BASED, GUMCADV2 AND CTAD)

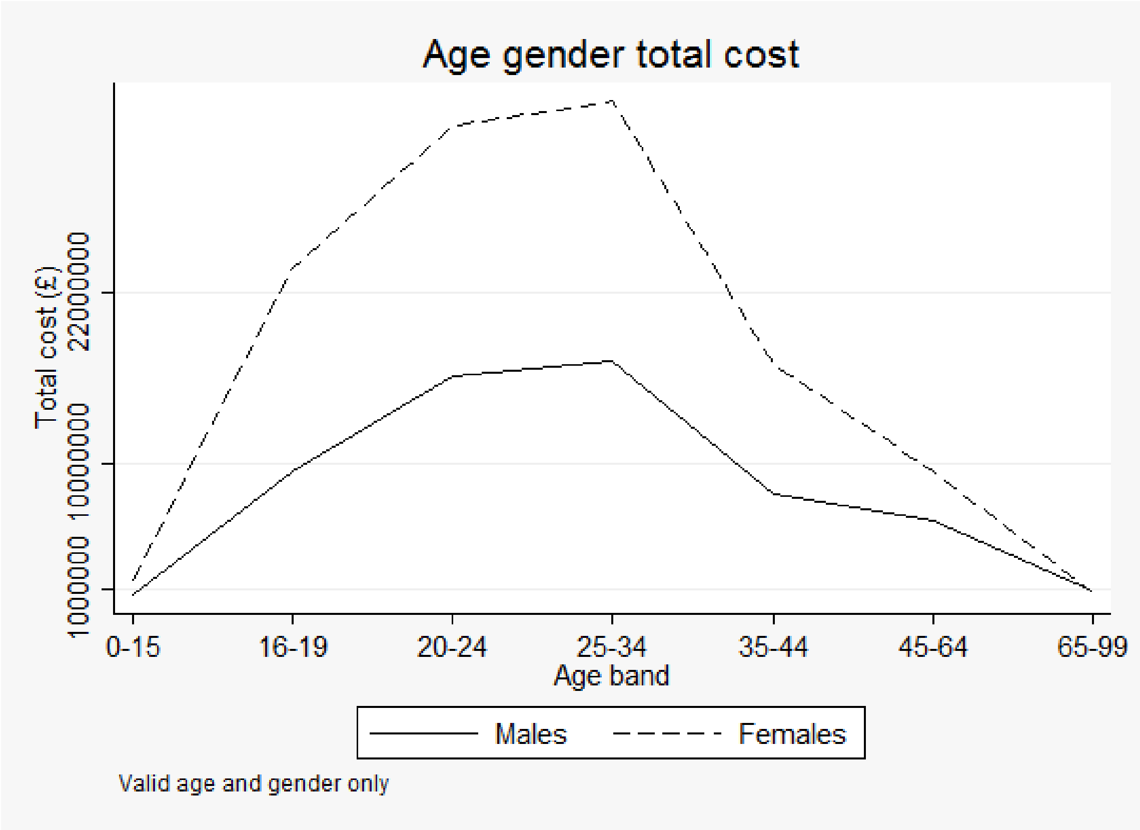
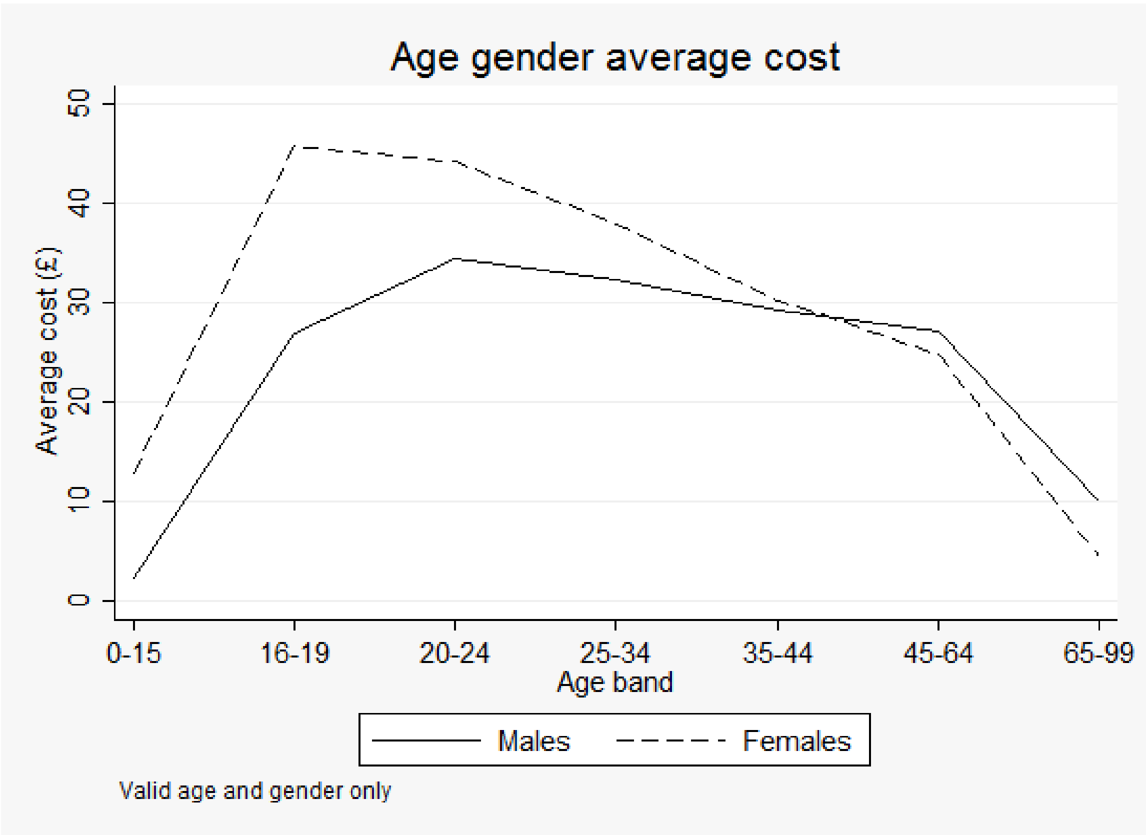


FIGURE 14 SEXUAL HEALTH: AVERAGE COSTED ACTIVITY (PERSON-BASED, GUMCADV2 AND CTAD) (PATIENTS)



LSOA AGE AND GENDER

An age, gender, and LSOA level sexual health activity dataset for England is obtained by summing all costed sexual health activity in GUMCADv2 and CTAD. In a similar fashion to the person based approach, we exclude any chlamydia related tests or diagnoses from the costed activity in GUMCADv2 and sum to LSOA age and gender level. The dataset contains 457,828 LSOA age and gender groups and a total costed activity of £179,989,104. Table 31 and Figures 15 and 16 give the total and average costs by age group and gender.

TABLE 31 SEXUAL HEALTH: TOTAL LSOA CTAD COSTED AND GUMCADV2 ACTIVITY BY AGE GROUP AND GENDER

	Total cost (£)			Ave cost (£)		
Age band	Male	Female	Total	Male	Female	Total
0-15	613,587	1,609,149	2,222,736	0	0	0
	32,702	32,702	65,404	32,702	32,702	65,404
16-19	9,449,458	23,783,502	33,232,960	6	15	10
	32,702	32,702	65,404	32,702	32,702	65,404
20-24	16,184,536	33,870,520	50,055,056	9	19	14
	32,702	32,702	65,404	32,702	32,702	65,404
25-34	17,181,540	35,612,036	52,793,576	5	10	7
	32,702	32,702	65,404	32,702	32,702	65,404
35-44	7,722,958	17,069,582	24,792,540	2	5	3
	32,702	32,702	65,404	32,702	32,702	65,404
45-64	5,874,596	9,357,825	15,232,421	1	1	1
	32,702	32,702	65,404	32,702	32,702	65,404
65-99	867,312	792,507	1,659,819	0	0	0
	32,702	32,702	65,404	32,702	32,702	65,404
Total	57,893,987	122,095,121	179,989,108	3	7	5
	228,914	228,914	457,828	228,914	228,914	457,828

Costs rounded to nearest £, sample size reported below cost, average cost is per capita

FIGURE 15 SEXUAL HEALTH: TOTAL COSTED ACTIVITY (LSOA) (GUMCADV2 AND CTAD)

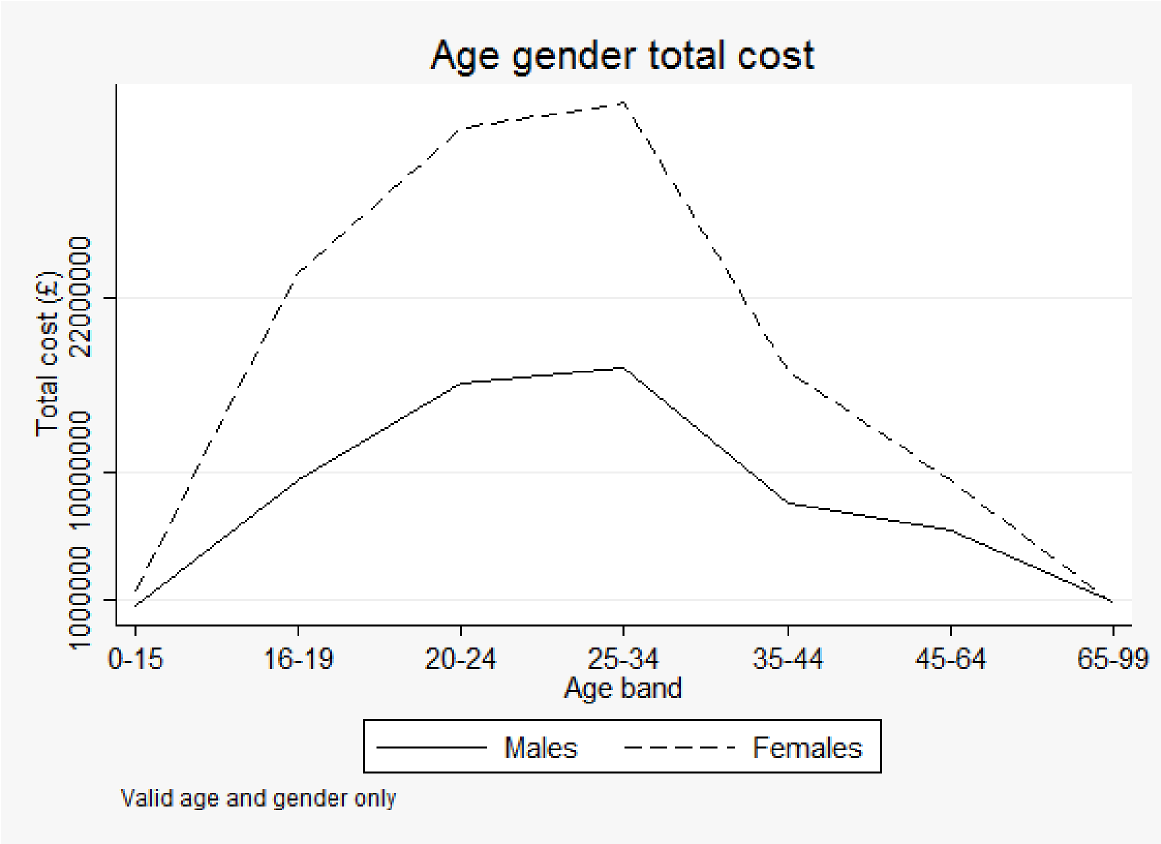
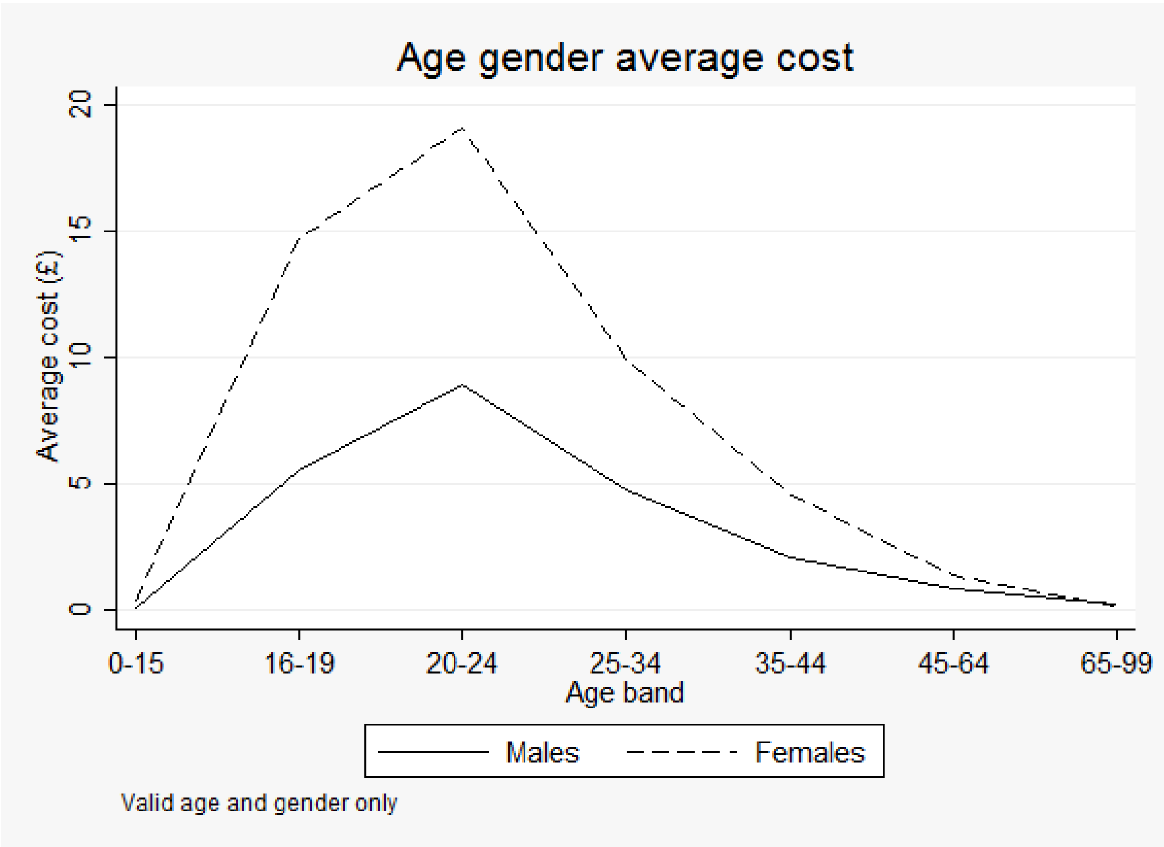


FIGURE 16 SEXUAL HEALTH: AVERAGE COSTED ACTIVITY (LSOA, GUMCADV2 AND CTAD) (PER CAPITA)



CORRELATIONS BETWEEN GUMCADV2/CTAD AND SRHAD

The three model specifications each have strengths and weaknesses. For model 1, the person-based model using only GUMCADv2, chlamydia testing outside of GUM clinics is not captured. For model 2 we cannot observe lagged use in the CTAD data that matches well with historic activity in GUMCADv2 meaning only GUMCADv2 historic activity is modelled and the apportioning of CTAD activity makes the person-based costed activity less accurate. For model 3 we lose all information on historic activity and variations within LSOA age and gender groups. For all cases sexual and reproductive health services are not captured.

To assess whether the models will differ in the proceeding analysis we correlated at the LSOA age and gender level costed activity in the three model specifications. Since models 2 and 3 have the same LSOA age and gender costs this amounts to assessing the correlation between costed activity in GUMCADv2 (including all chlamydia tests and diagnoses) and costed activity in GUMCADv2 (excluding chlamydia tests and diagnoses) and CTAD. A correlation of 0.3692 was found, suggesting the three model specifications are picking up different types of activity and the results from the analysis will depend on the preferred specification chosen.

To test for how diverse activity is between SRHAD and GUMCADv2/CTAD activity we correlated total (upper tier, unitary Local Authority) contacts reported in SRHAD with costed activity in GUMCAD/CTAD for the three model specifications (see Table 32). There are 150 upper tier Local Authorities in England (due to small numbers, Isle of Sicilly is merged with Cornwall, and City of London with Hackney). The correlation of SRHAD contacts with GUMCADv2/CTAD costs for 2013/14 was 0.6511 in model 1 and 0.6927 for models 2 and 3 (0.5138 and 0.5388 for contraceptive activity). The strong correlation between SRHAD contacts and costed GUMCADv2/CTAD activity suggests a resource allocation formula that uses weights derived from GUMCADv2 and CTAD data will be likely to be broadly in line with the needs for sexual and reproductive services at the upper tier LA level. A strong correlation between model 1 costed activity and model 2 and 3 costed activity was also found at the upper tier LA level (0.8930).

TABLE 32 SEXUAL HEALTH: CORRELATIONS BETWEEN ACTIVITY IN SRHAD WITH COSTED ACTIVITY IN GUMCADV2 AND CTAD

	Costed activity model 1 (person-based GUMCADv2)	Costed activity model 2 (person-based GUMCADv2 and LSOA apportioned CTAD)	Costed activity model 3 (LSOA age and gender GUMCADv2 and CTAD)	SRHAD total contacts	SRHAD total contraceptive activity
Costed activity model 1 (person-based GUMCADv2)	1.00				
Costed activity model 2 (person-based GUMCADv2 and LSOA apportioned CTAD)	0.8930	1.00			
Costed activity model 3 (LSOA age and gender GUMCADv2 and CTAD)	0.8930	1.00	1.00		
SRHAD total contacts	0.6511	0.6927	0.6927	1.00	
SRHAD total contraceptive activity	0.5138	0.5388	0.5388	0.8229	1.00

ECONOMETRIC ANALYSIS

Once we have costed utilisation, there are three model specifications:

1. Person-based – using GUMCADv2
2. Person-based – using GUMCADv2 and CTAD
3. LSOA age and gender – using GUMCADv2 and CTAD

PERSON-BASED FORMULA USING GUMCADV2

This approach makes use of historic utilisation data and person level characteristics. Individual level data on use for at least the previous year is needed as past use of sexual health services may be a good predictor of current expenditure. Ordinary least squares regression models are used to estimate the effects of lagged use on an individual's expenditure in the current year. This approach can also include local needs and supply characteristics of the population.

For the person-based approach we create a dataset of users and non-users of sexual health activity in GUMCADv2. The number of non-users is derived by subtracting the number of users in an LSOA by the total ONS LSOA population.

PERSON-BASED FORMULA USING GUMCADV2 AND CTAD

This approach is identical to the approach taken in 1 though CTAD activity is apportioned to individuals and LSOA age and gender groups on a per capita basis.

LSOA AGE AND GENDER USING GUMCADV2 AND CTAD

This approach models the difference in actual expenditure by gender and age group for each LSOA to average expenditure by gender and age group for the English population. The first step is to calculate actual and expected expenditure adjusted for age and gender. The second stage is to identify how and if characteristics of that area explain differences in the ratio of actual to expected expenditure (typically via weighted least squares).

An alternative approach can be taken at LSOA age and gender level whereby analysis is performed separately for different age groups (age stratified models). This approach permits different characteristics to explain expenditure for different age groups. Early suggestions include <25's and >25's given the Public Health Outcomes Framework for chlamydia testing of under 25s (Department of Health, 2013) and evidence of prevalence for those aged under 25 from Public Health England reports (for example: Public Health England, 2014b).

NEEDS MEASURES

To identify potential needs measures we initially investigated key drivers highlighted in reports by Public Health England. The most recent Public Health England report on STI (Public Health England, 2014b) reported approximately 450,000 STI diagnoses in England in 2013. This fell disproportionately on heterosexual males aged under 25, and amongst men who have sex with men. The most common STI was chlamydia (making up 208,755 of the 446,253 STI diagnoses; 47%), and a marked increase in gonorrhoea was noticed (15% from 2012 to 2013, 26% amongst men who have sex with men). The most prevalent conditions were: chlamydia (47%), genital warts (17%), genital herpes (7%), and gonorrhoea (7%). Diagnoses vary according to sexual orientation, for men who have sex with men syphilis (74%) and gonorrhoea (46%) were the most common diagnoses, for heterosexual males genital warts (49%) and heterosexual females genital herpes (60%) and chlamydia (46%).

Sexual orientation and age play an important factor in identifying the needs for sexual health services. Differences are also observed by rurality, with diagnoses rates higher in urban areas (Public Health England, 2014b). Rates of STIs were also reported to be higher for those of Black ethnicity.

A new sexual and reproductive health profiles tool was rolled out in April 2014: http://fingertips.phe.org.uk/profile/sexualhealth/data (PHE, 2014c) the profiles summarise a variety of local area characteristics. The characteristics include: STI diagnoses rates per 100,000; abortions<10 weeks; under 25 repeat abortions; GP prescribed long acting reversible contraception 1,000, pelvic inflammatory disease admissions; ectopic pregnancy admissions; cervical cancer registrations; under 18s conception rate 1,000; under 18s conceptions leading to abortion; sexual offences rate 1,000. The lowest geography measured is LA. The sexual health profile key indicators are available at LA level (n=150). Analysis using these measures is not compatible with LA fixed-effects.

Since these potential needs measures are unlikely to be identical by age and gender group across Local Authorities, and more likely to distinguish need than a single SMR rate, the existing formula is unlikely to be a good proxy for the relative need for sexual health services. Additional measures for need were sourced at MSOA and LSOA level (see Table 33 for the full list of need and supply measures).

For all models we group age into the following groups: <15, 15-19, 20-24, 25-34, 35-64, and 65+.

TABLE 33 SEXUAL HEALTH: NEED AND SUPPLY INDICATORS

		Source	Note
Current formula	National prevalence		Do not vary by LSOA/LA/PCT
	MSOA SMR	2008-2012 PHO	
	MSOA SMR SQROOT	2008-2012 PHO	
PHE key sexual health profile	Syphilis diagnosis rate / 100,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Gonorrhoea diagnosis rate / 100,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Chlamydia diagnosis rate / 100,000 aged 15-24 (PHOF indicator 3.02)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Chlamydia proportion aged 15-24 screened	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Genital warts diagnosis rate / 100,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Genital herpes diagnosis rate / 100,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	All new STI diagnoses (exc Chlamydia aged <25) / 100,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	HIV testing uptake, MSM (%)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	HIV late diagnosis (%) (PHOF indicator 3.04)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	HIV diagnosed prevalence rate / 1,000 aged 15-59	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Population vaccination coverage - HPV	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Abortions under 10 weeks (%)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Under 25s repeat abortions (%)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	GP prescribed LARC rate / 1,000	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Under 18s conception rate / 1,000 (PHOF indicator 2.04)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
	Under 18s conceptions leading to abortion (%)	http://fingertips.phe.or	LA level, small

		g.uk/profile/sexualhealth	numbers
	Sexual offences rate / 1,000 (PHOF indicator 1.12iii)	http://fingertips.phe.org.uk/profile/sexualhealth	LA level, small numbers
PHE HPA reports	IMD 2010: total score		LSOA
	IMD 2010: crime score		LSOA
	IMD 2010: environment score		LSOA
	IMD 2010: barriers to housing/ services score		LSOA
	IMD 2010: education skills/ training score		LSOA
	IMD 2010: health deprivation/ disability score		LSOA
	IMD 2010: income score		LSOA
	IMD 2010: employment score		LSOA
	IMD 2010: years potential longstanding illness		LSOA
	IMD 2010: mood or anxiety rate		LSOA
	IMD 2010: acute morbidity rate		LSOA
	Benefits: Incapacity Benefit/ Severe Disablement Allowance (IB/ SDA 2010, rate per total pop 2011)		LSOA
	Benefits: Income Support (IS 2010, rate per total pop 2011)		LSOA
	Benefits: Disability Living Allowance (DLA 2010, rate per total pop 2011)		LSOA
	Benefits: Jobseekers Allowance (2010, rate per total pop 2011)		LSOA
	One adult in household (rate per all usual residents, 2011)		LSOA
	NS-SEC long-term unemployed (rate per total aged 18-64, 2011)		LSOA
	Unemployed rate 2010		LSOA
	Day-to-day activities limited a lot (rate per all usual residents, 2011)		LSOA
	Population density (n of usual residents per hectare, 2011)		LSOA
	Average household size		LSOA
	No qualifications (rate per total aged 16+ pop, 2011)		LSOA
	% no religion		LSOA
	Ethnicity: mixed; Asian; Black; Other; White British; White other		LSOA
	Marital status: Single; Married; Same-sex civil partnership; Separated; Divorced; Widowed		LSOA
	Urban identifier		LSOA
Supply	Presence of GUM clinic		LSOA
	Distance to nearest GUM clinic		LSOA
	Distance to Wales		LSOA
	LA fixed-effects		LA

EMPIRICAL STRATEGY FOR IDENTIFYING NEEDS MEASURES

The empirical strategy to identify additional needs factors is as follows:

1. **Estimate the current approach for modelling need:**
   a. National prevalence by age and gender (2010 England prevalence by age group (for chlamydia, gonorrhoea, syphilis, herpes, warts) – data from GUMCADv2 and CTAD – current exposition book)
   b. MSOA SMR – all cause mortality from 2008-2012 from Public Health Observatories
2. **Estimate effects of variables informed from PHE sexual health profile on key indicators (see Table 11)**
3. **Estimate effects of variables identified from PHE HPA annual reports and additional need measures (see Table 11)**
   a. From PHE HPA annual reports
   b. Other needs measures

SUPPLY MEASURES

We model four sources of potential supply:

a. Presence of a GUM clinic in the LSOA
b. Distance to closest LSOA containing a clinic
c. Distance to closest LSOA in Wales (*insignificant for each specification)
d. LA effects (via fixed-effects regression).

STATISTICAL INFERENCE/MODEL ASSESSMENT CRITERIA

For each of the three model specifications (person-based GUMCADv2; person-based GUMCADv2 and CTAD; and LSOA) we identify the needs variables as follows:

Step 1

Estimate the current approach for modelling need. That is, model costed activity with only SMR as the needs measure.

Step 2

Estimate effects of variables informed from PHE sexual health profile on key indicators (see Table 33). That is, model costed activity with only the PHE sexual health profile key indicators as the needs measures. Includes supply factors.

Step 3

Estimate effects of variables identified from PHE HPA annual reports and additional need measures (see Table 33).

To identify potential needs variable candidates we:

a) Correlate each needs variable and identify which variables have a correlation greater than 0.7
b) Separately regress costed activity on each needs variable with supply variables included
c) Choose needs variable that leads to a higher R2

This approach reduces the potential for collinearity in the needs variables.

Step 4

To identify the final model specification we:

a) Regress costed activity on all needs variables (excluding those dropped at Stage 3, with ethnic and marital status variables chosen on the basis of discussions with ACRA/TAG/PHE reports)
b) Drop the variable that is the most insignificant (highest p-value)
c) Re-estimate the model and re-iterate b) until all variables are significant (p-value<0.05)

Models are assessed on the amount of explained variation of actual to expected costs (R-squared), variables are assessed via their significance. Standard errors are robust to heteroskedasticity and clustered at LA level. All analyses were conducted in STATA v13.

SENSITIVITY ANALYSIS

We estimate several models using a variety of GUMCADv2 and CTAD data to see whether the results vary depending on the level (person-based or LSOA-based) and source (GUMCADv2 only or GUMCADv2 and CTAD) of activity modelled.

We conduct further sensitivity analysis by excluding the ‘high cost’ patients/LSOAs accounting for the top 1% of costs.

RESULTS

The mean and standard deviation of each of the needs measures are contained in Table 34 (the descriptive statistics for the dependent variables (costed activity) are contained earlier in the report).

TABLE 34 SEXUAL HEALTH: SUMMARY STATISTICS OF THE NEEDS AND SUPPLY VARIABLES

Variable	Mean	Std. Dev.	Min	Max
Syphilis diagnosis rate / 100,000	5.103	1.571	1.800	9.800
Gonorrhoea diagnosis rate / 100,000	79.522	4.891	55.570	87.400
Chlamydia diagnosis rate / 100,000 aged 15-24 (PHOF indicator 3.02)	1,029.567	619.843	348.730	3,269.370
Chlamydia proportion aged 15-24 screened	8.746	2.617	3.010	17.360
Genital warts diagnosis rate / 100,000	2,127.099	789.943	839.990	5,758.490
Genital herpes diagnosis rate / 100,000	2,176.206	711.554	947.970	4,910.510
All new STI diagnoses (exc Chlamydia aged <25) / 100,000	26.127	8.452	10.640	58.170
HIV testing uptake, MSM (%)	30.432	7.384	14.440	51.630
HIV late diagnosis (%) (PHOF indicator 3.04)	96.161	26.476	14.010	173.080
HIV diagnosed prevalence rate / 1,000 aged 15-59	468.269	137.659	171.040	846.510
Population vaccination coverage - HPV	61.310	5.004	43.710	81.940
Abortions under 10 weeks (%)	48.229	20.625	7.480	96.330
Under 25s repeat abortions (%)	69.907	33.211	21.420	182.850
GP prescribed LARC rate / 1,000	149.060	48.322	70.720	288.570
Under 18s conception rate / 1,000 (PHOF indicator 2.04)	85.689	104.626	3.600	533.200
Under 18s conceptions leading to abortion (%)	3.009	3.047	0.370	14.700
Sexual offences rate / 1,000 (PHOF indicator 1.12iii)	85.912	3.620	63.310	100.000
smr	106.870	34.109	36.750	277.840
smrsqroot	10.214	1.595	6.062	16.669
IMD 2010: total score	0.125	0.813	-2.890	3.810
IMD 2010: crime score	24.178	17.596	0.060	92.990
IMD 2010: environment score	22.406	11.137	0.340	70.140
IMD 2010: barriers to housing/ services score	22.404	18.867	0.010	99.340
IMD 2010: education skills/ training score	0.071	0.875	-3.100	3.790
IMD 2010: health deprivation/ disability score	0.158	0.114	0.010	0.770
IMD 2010: income score	0.103	0.066	0.000	0.750
IMD 2010: employment score	69.160	17.054	30.610	184.130
IMD 2010: years potential longstanding illness	116.892	44.594	31.860	355.180
IMD 2010: mood or anxiety rate	-0.002	0.758	-2.800	3.320
IMD 2010: acute morbidity rate	124.289	33.696	46.830	367.570
Benefits: Incapacity Benefit/ Severe Disablement Allowance (IB/ SDA 2010, rate per total pop 2011)	0.049	0.027	0.000	0.258
Benefits: Income Support (IS 2010, rate per total pop 2011)	0.031	0.025	0.000	0.187
Benefits: Disability Living Allowance (DLA 2010, rate	0.033	0.022	0.000	0.193

per total pop 2011)				
Benefits: Jobseekers Allowance (2010, rate per total pop 2011)	0.024	0.017	0.000	0.168
One adult in household (rate per all usual residents, 2011)	0.107	0.053	0.007	0.837
NS-SEC long-term unemployed (rate per total aged 18-64, 2011)	0.021	0.014	0.000	0.129
Unemployed rate 2010	0.054	0.028	0.006	0.284
Day-to-day activities limited a lot (rate per all usual residents, 2011)	0.081	0.035	0.004	0.300
Population density (n of usual residents per hectare, 2011)	49.786	47.300	0.000	684.700
Average household size	2.403	0.339	1.100	5.000
No qualifications (rate per total aged 16+ pop, 2011)	0.221	0.096	0.005	0.601
% no religion	0.255	0.090	0.001	0.642
% mixed	0.025	0.020	0.000	0.149
% Asian	0.092	0.144	0.000	0.987
% Black	0.041	0.074	0.000	0.650
% other	0.012	0.020	0.000	0.366
% White British	0.765	0.244	0.006	0.997
% White other	0.064	0.064	0.000	0.495
% single	0.378	0.143	0.083	0.971
% married	0.439	0.131	0.018	0.875
% same-sex civil	0.002	0.003	0.000	0.047
% separated	0.027	0.011	0.001	0.095
% divorced	0.088	0.028	0.003	0.234
% widowed	0.064	0.028	0.000	0.262
Urban identifier	0.862	0.345	0.000	1.000
Presence of GUM clinic	0.009	0.096	0.000	1.000
Distance to nearest GUM clinic	6088.912	5826.959	0.000	79827.180
Distance to Wales	21788.040	24371.740	151.447	214153.10

PERSON-BASED FORMULA USING GUMCADV2

The results from regressing costed activity using SMR, and the PHE key indicators are provided in Table 36. A look up table is provided for PHE indicator values for presentational reasons (Table 35). Individuals who were present in GUMCADv2 in the previous year (2012-13) have a higher cost in 2013-14 of approximately £38. Females have an approximate £0.26 higher cost. Age effects peak at 20-24. Note that the sample size does not match that in the costings because a number of LSOA age groups have more users than population estimates. We weight these at zero.

The final model specifications for the person-based model are provided in Table 37. We selected the variables in accordance to the procedure contained in ‘statistical inference/ model assessment criteria’. All models with no PHE indicators have LA dummies. The PHE models are used for comparison. High cost individuals/LSOAs are removed to compare how sensitive the final model specification is to high cost individuals/areas.

The following sets of collinear variables were:

1. SMR, SMRsqroot, IMD 2010 Health, IMD 2010 comparative illness: IMD 2010 Health had the largest R2
2. IMD 2010 Education, IMD 2010 Income, IMD 2010 Employment, Disability living allowance, Income Support rate, Incapacity Benefit rate, NSSEC Long term unemployed rate, unemployment rate, no qualifications rate: no qualifications rate had the largest R2
3. IMD 2010 Health, IMD 2010 Employment, IMD 2010 years of potential illness, IMD 2010 acute morbidity, IMD 2010 mood anxiety: IMD 2010 mood and anxiety had the highest R2
4. No qualifications, day to day activity: day to day activity had the highest R2

For ethnicity we selected the proportion black/Caribbean and White other.

For marital status we selected proportion same-sex civil partnerships, and proportion single.

For household composition we selected the average household size.

TABLE 35 SEXUAL HEALTH: PHE KEY INDICATOR VALUE LOOK UP TABLE

	Indicator	Look up value number
PHE key sexual health profile	Syphilis diagnosis rate / 100,000	1
	Gonorrhoea diagnosis rate / 100,000	2
	Chlamydia diagnosis rate / 100,000 aged 15-24 (PHOF indicator 3.02)	3
	Chlamydia proportion aged 15-24 screened	4
	Genital warts diagnosis rate / 100,000	5
	Genital herpes diagnosis rate / 100,000	6
	All new STI diagnoses (exc Chlamydia aged <25) / 100,000	7
	HIV testing uptake, MSM (%)	8
	HIV late diagnosis (%) (PHOF indicator 3.04)	9
	HIV diagnosed prevalence rate / 1,000 aged 15-59	10
	Population vaccination coverage - HPV	11
	Abortions under 10 weeks (%)	12
	Under 25s repeat abortions (%)	13
	GP prescribed LARC rate / 1,000	14
	Under 18s conception rate / 1,000 (PHOF indicator 2.04)	15
	Under 18s conceptions leading to abortion (%)	16
	Sexual offences rate / 1,000 (PHOF indicator 1.12iii)	17

TABLE 36 SEXUAL HEALTH: SMR, AND PHE KEY INDICATOR MODELS (PERSON-BASED - GUMCADV2)

	SMR		SMR Ex. High cost		PHE key indicators		PHE key indicators Ex. High cost	
Patient 2012-13	38.4065**	(0.0855)	10.6611**	(0.0298)	38.3798**	(0.0909)	10.3057**	(0.0316)
Female	0.2593**	(0.0105)	0.0979**	(0.0045)	0.2712**	(0.0114)	0.1048**	(0.0048)
Age 0-14	-5.1271**	(0.0246)	-2.3190**	(0.0112)	-4.8925**	(0.0265)	-2.2276**	(0.0119)
Age 15-19	-1.0323**	(0.0354)	-0.8089**	(0.0146)	-0.7291**	(0.0373)	-0.6970**	(0.0153)
Age 20-24	2.9890**	(0.0528)	1.0676**	(0.0228)	3.0886**	(0.0547)	1.0878**	(0.0235)
Age 35-44	-3.2552**	(0.0271)	-1.4691**	(0.0121)	-3.0656**	(0.0291)	-1.3871**	(0.0129)
Age 45-64	-4.4473**	(0.0251)	-2.0085**	(0.0113)	-4.1335**	(0.0267)	-1.8822**	(0.0119)
Age 65-99	-5.0496**	(0.0247)	-2.2887**	(0.0112)	-4.6748**	(0.0260)	-2.1412**	(0.0117)
SMR	0.0038**	(0.0002)	0.0012**	(0.0001)				
1 value					-0.0609**	(0.0052)	0.0406**	(0.0022)
2 value					-0.0045**	(0.0013)	-0.0035**	(0.0006)
3 value					0.0024**	(0.0000)	0.0010**	(0.0000)
4 value					0.0218**	(0.0026)	-0.0158**	(0.0011)
5 value					-0.0002**	(0.0000)	-0.0001**	(0.0000)
6 value								
7 value								
8 value					-0.0056**	(0.0010)	-0.0035**	(0.0004)
9 value					-0.0010**	(0.0003)	-0.0004**	(0.0001)
10 value					-0.0013**	(0.0001)	-0.0001**	(0.0000)
11 value					0.0156**	(0.0017)	0.0150**	(0.0007)
12 value								
13 value								
14 value								
15 value								
16 value								
17 value					0.0060**	(0.0014)		
Clinic					23.3937**	(0.4854)	16.8441**	(0.2233)
Distance to clinic					-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	4.6794**	(0.0304)	2.2161**	(0.0134)	3.1970**	(0.2030)	1.2736**	(0.0649)
N	2574306		2106977		2386332		1951075	
r2	0.0792		0.0439		0.0830		0.0479	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

The final model was selected by the stepwise approach discussed in the methods. Where perverse signed variables were observed these were omitted on a step by step basis, this occurred for:

- Population density was insignificant
- IMD 2010 crime was negative
- IMD 2010 barriers to housing was insignificant
- Urban was negative
- Day to day activity limited was positive (and IMD mood and anxiety greater)
- Proportion single was negative
- Proportion with no religion was negative
- Proportion white other ethnicity was insignificant

- Day to day activity limited was obscuring jobseekers (jobseekers negative but positive when Day to day activity limited is removed)
- Proportion same-sex civil partnerships was insignificant

TABLE 37 SEXUAL HEALTH: FINAL MODEL SPECIFICATIONS FOR PERSON-BASED GUMCADV2

	Final		Final exc high cost	
Patient 2012-13	37.3997**	(0.0868)	10.0517**	(0.0305)
Female	0.2627**	(0.0111)	0.1002**	(0.0047)
Age 0-14	-4.8936**	(0.0258)	-2.2289**	(0.0116)
Age 15-19	-0.7334**	(0.0358)	-0.6985**	(0.0148)
Age 20-24	3.1554**	(0.0524)	1.1180**	(0.0228)
Age 35-44	-3.0633**	(0.0283)	-1.3940**	(0.0126)
Age 45-64	-4.1208**	(0.0259)	-1.8859**	(0.0116)
Age 65-99	-4.6577**	(0.0253)	-2.1483**	(0.0114)
IMD (2010) Environment Score	0.0050**	(0.0005)	0.0019**	(0.0002)
Jobseekers allowance claimant rate	4.2746**	(0.5783)	-0.5505*	(0.2456)
Average household size	-0.1662**	(0.0263)	-0.2012**	(0.0113)
Proportion Black	3.4151**	(0.2167)	1.3263**	(0.0909)
Clinic	24.5326**	(0.4683)	17.1759**	(0.2181)
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	5.0637**	(0.0713)	2.7465**	(0.0310)
N	2574306		2106977	
r2	0.0822		0.0485	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

PERSON-BASED FORMULA USING GUMCADV2 AND CTAD

The person-based approach where CTAD costed activity is apportioned on a per capita basis to GUMCADv2 costed activity contains an approximate additional £20million. This approach enables a comparison to the person-based GUMCADv2 approach to see whether using chlamydia testing from CTAD differs from chlamydia testing in GUMCADv2. Tables 38 and 39 give the SMR, PHE sexual health profiles, and final specifications.

The estimated effect for GUMCADv2 activity in 2012-13 is lower than the GUMCADv2 model due to the inclusion of CTAD activity.

The final model was selected by the stepwise approach discussed in the methods and for the GUMCADv2 person-based model (1). Where perverse signed variables were observed these were omitted on a step by step basis, this occurred for:

- Population density was insignificant
- IMD 2010 crime was negative
- IMD 2010 barriers to housing was insignificant
- Urban was negative
- Day to day activity limited was positive (and IMD mood and anxiety greater)

- Proportion single was negative
- Proportion with no religion was negative
- Proportion white other ethnicity was insignificant
- Day to day activity limited was obscuring jobseekers (jobseekers negative but positive when Day to day activity limited is removed)

Note how this aligns with the GUMCADv2 model (1). Although Day to day is removed as it is insignificant and the proportion of same-sex civil partnerships is significant. Excluding high costs removes the IMD 2010 Environment variable (insignificant) though Jobseekers remains significant unlike the GUMCADv2 only model (1).

TABLE 38 SEXUAL HEALTH: SMR, AND PHE KEY INDICATOR MODELS (PERSON-BASED - GUMCADV2 AND CTAD)

	SMR		SMR Ex. High cost		PHE key indicators		PHE key indicators Ex. High cost	
Patient 2012-13	20.8055**	(0.0742)	3.9191**	(0.0169)	19.8984**	(0.0789)	3.7456**	(0.0180)
Female	2.4045**	(0.0282)	1.9586**	(0.0084)	2.4268**	(0.0285)	1.9704**	(0.0085)
Age 0-14	-5.7804**	(0.0567)	-3.5879**	(0.0175)	-5.5788**	(0.0572)	-3.5809**	(0.0175)
Age 15-19	3.2545**	(0.1323)	2.4235**	(0.0339)	3.5645**	(0.1309)	2.5087**	(0.0335)
Age 20-24	5.9203**	(0.1273)	3.7793**	(0.0365)	6.0809**	(0.1263)	3.8613**	(0.0365)
Age 35-44	-3.1547**	(0.0618)	-1.7441**	(0.0193)	-3.0411**	(0.0636)	-1.7499**	(0.0195)
Age 45-64	-5.0046**	(0.0566)	-3.0541**	(0.0177)	-4.8193**	(0.0573)	-3.0651**	(0.0177)
Age 65-99	-5.8733**	(0.0559)	-3.7116**	(0.0175)	-5.6485**	(0.0559)	-3.7234**	(0.0174)
SMR	0.0174**	(0.0006)	0.0077**	(0.0002)				
1 value					-0.0679**	(0.0122)	-0.0208**	(0.0037)
2 value					0.0073*	(0.0036)	0.0047**	(0.0011)
3 value								
4 value					-0.0160*	(0.0063)		
5 value								
6 value								
7 value					0.1192**	(0.0066)	0.0295**	(0.0012)
8 value					-0.0350**	(0.0039)	0.0078**	(0.0010)
9 value								
10 value					0.0003*	(0.0001)	0.0005**	(0.0000)
11 value					-0.0138**	(0.0038)	-0.0207**	(0.0012)
12 value					0.0089**	(0.0010)	0.0067**	(0.0004)
13 value								
14 value								
15 value					0.0086**	(0.0005)	0.0020**	(0.0001)
16 value								
17 value					-0.0244**	(0.0031)	0.0025*	(0.0012)
Clinic					51.3687**	(0.8060)	7.0284**	(0.0989)
Distance to clinic					-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	2.9878**	(0.0708)	2.0056**	(0.0220)	4.7327**	(0.5275)	2.0295**	(0.1532)
N	2574478		2117361		2433041		2051920	
r2	0.0661		0.2724		0.0768		0.2787	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

TABLE 39 SEXUAL HEALTH: FINAL MODEL SPECIFICATIONS FOR PERSON-BASED GUMCADV2 AND CTAD

	Final		Final exc high cost	
Patient 2012-13	19.3933**	(0.0791)	3.7206**	(0.0176)
Female	2.4133**	(0.0282)	1.9609**	(0.0083)
Age 0-14	-5.4805**	(0.0535)	-3.5275**	(0.0167)
Age 15-19	3.5931**	(0.1319)	2.4856**	(0.0328)
Age 20-24	6.0770**	(0.1266)	3.7951**	(0.0353)
Age 35-44	-2.9461**	(0.0601)	-1.7054**	(0.0186)
Age 45-64	-4.6719**	(0.0534)	-2.9988**	(0.0169)
Age 65-99	-5.4975**	(0.0520)	-3.6550**	(0.0167)
IMD (2010) Environment Score	0.0069**	(0.0015)		
Jobseekers allowance claimant rate	27.4515**	(2.3129)	9.9851**	(0.4552)
Average household size	-0.8827**	(0.0614)	-0.3975**	(0.0209)
Proportion Black	2.9728**	(0.4476)	1.7521**	(0.1615)
Proportion same-sex civil partnership	93.5247**	(23.6625)	15.6218**	(2.4789)
Clinic	52.4674**	(0.8765)	6.8664**	(0.0985)
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	5.7775**	(0.1667)	3.4301**	(0.0563)
N	2574478		2117361	
r2	0.0743		0.2845	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

LSOA AGE AND GENDER USING GUMCADV2 AND CTAD

The dependent variable for the LSOA age and gender analysis is the actual to expected cost for each LSOA age and gender group. The expected cost is determined by calculating the average cost of GUMCADv2 and CTAD activity by age and gender in England (here, the 32,702 LSOA's in the dataset). Dividing the actual recorded cost to the expected cost gives the actual-expected ratio.

The mean actual-expected ratio is 1 by construction of the ratio. The actual-expected ratio in the data has a standard deviation of 1.91. The distribution of the ratio is provided in Figure 17 for all and for where the ratio is less than 4. Aside from the large tail (the maximum value of the ratio is 98.46), the distribution is fairly normal.

The LSOA approach is similar to the person-based GUMCADv2 and CTAD (model 2) approach but with the unit of analysis LSOA and the removal of lagged GUMCADv2 use. This approach enables a comparison to the person-based GUMCADv2 and CTAD approach to see whether using LSOA differs from person-based. Tables 40 and 41 give the SMR, PHE sexual health profiles, and final specifications.

Table 41 provides the results for all ages and where we split the LSOA analysis by ages 24 and under and 25 and over.

For the all age model the following sets of collinear variables were:

1. SMR, SMRsqroot, IMD 2010 Health, IMD 2010 comparative illness: IMD 2010 Health had the largest R2
2. IMD 2010 Education, IMD 2010 Income, IMD 2010 Environment, IMD 2010 Employment, Income Support rate, Incapacity Benefit rate, NSSEC Long term unemployed rate, unemployment rate, no qualifications rate: IMD Employment had the largest R2
3. IMD 2010 Health, IMD 2010 Employment, IMD 2010 years of potential illness, IMD 2010 acute morbidity, IMD 2010 mood anxiety, Jobseekers Allowance rate: Jobseekers Allowance had the highest R2

For ethnicity we selected the proportion black/Caribbean and White other. For marital status we selected proportion same-sex civil partnerships, and proportion single. For household composition we selected the average household size. The final model was selected by the stepwise approach discussed in the methods.

For the under 25's the same variables had the largest R2 in the collinear analysis but for the 25 and overs Income Support rate was higher than IMD 2010 Employment. This was then dropped as Jobseekers Allowance was highly correlated with it and had a higher R2.

Several measures are consistently found to be significant in the six models (Table 41):

- Rate of jobseekers allowance claimants
- Average household size
- Whether the individual resides in an area containing a GUM clinic (except >25s)
- Distance to closest GUM clinic

The proportion of the population black/Caribbean is positive and significant in the all age and 25 and over models. The R2 is higher for the LSOA approach due to a reduced variation to explain in contrast to the person-based approach.

FIGURE 17 SEXUAL HEALTH: ACTUAL-EXPECTED RATIO DISTRIBUTION

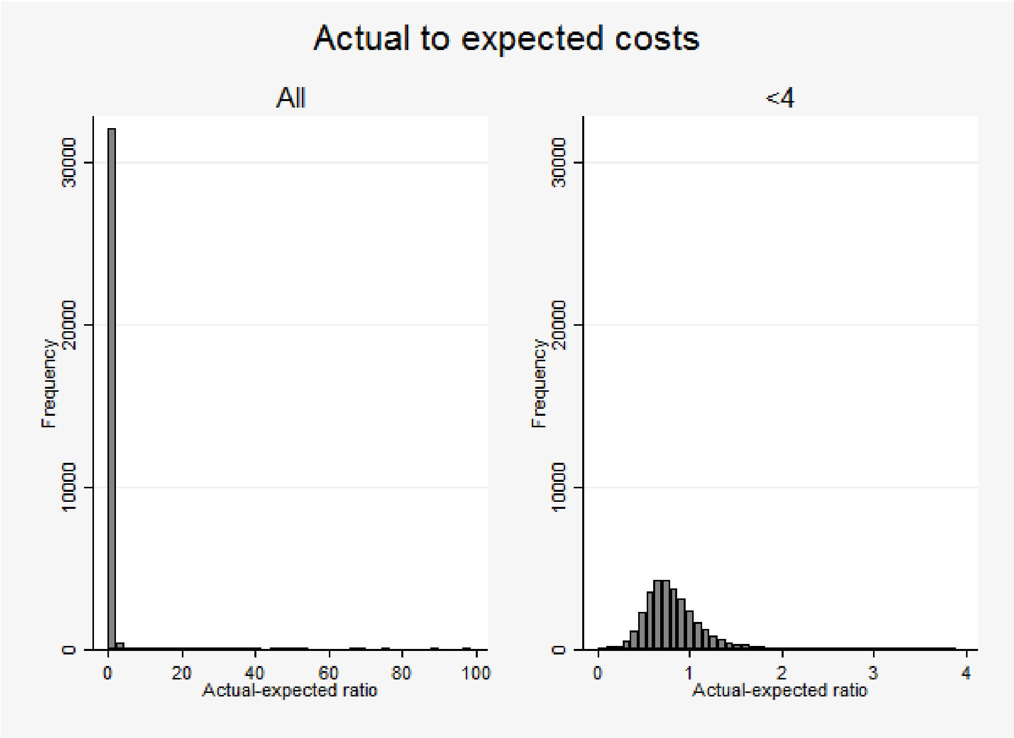


TABLE 40 SEXUAL HEALTH: SMR, AND PHE KEY INDICATOR MODELS (LSOA - GUMCADV2 AND CTAD)

	SMR		**SMR ex. High cost**		**PHE key indicators**		**PHE key indicators ex. high**	
SMR	0.0051**	(0.0005)	0.0026**	(0.0001)				
1 value								
2 value								
3 value								
4 value								
5 value								
6 value								
7 value					0.0303**	(0.0055)	0.0077**	(0.0006)
8 value					-0.0080**	(0.0031)	0.0013**	(0.0005)
9 value								
10 value								
11 value								
12 value								
13 value								
14 value								
15 value					0.0025**	(0.0004)	0.0020**	(0.0001)
16 value								
17 value								
Clinic					4.4375**	(0.8601)	0.2806**	(0.0613)
Distance to clinic					-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	0.4555**	(0.0447)	0.6019**	(0.0090)	0.3436**	(0.0767)	0.5852**	(0.0113)
N	32702		32458		32702		32458	
r2	0.0083		0.0471		0.0840		0.2671	

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$

TABLE 41 SEXUAL HEALTH: FINAL LSOA GUMCAD AND CTAD MODELS WITH AGE STRATIFICATION

	Final		Final <25		Final >=25		Final Ex. High cost		Final <25 Ex. High cost		Final >=25 Ex. High cost	
IMD 2010 environment score	0.0021*	(0.0011)										
Jobseekers allowance claimants (2010 rate)	7.7086**	(1.8841)	10.2738**	(1.8888)	5.1783**	(1.5031)	3.3267**	(0.2076)	3.7855**	(0.2345)	2.4341**	(0.2372)
Average Household Size	-0.2434**	(0.0443)	-0.2699**	(0.0545)	-0.1662**	(0.0437)	-0.1484**	(0.0099)	-0.1439**	(0.0137)	-0.1035**	(0.0085)
Prop Black/Caribbean	0.8494*	(0.3645)			1.6607**	(0.3862)	0.9384**	(0.0706)			1.3409**	(0.0738)
Prop single					0.5951**	(0.1577)					0.3524**	(0.0353)
Clinic	4.3933**	(0.8636)	4.2879**	(0.9011)	4.5254**	(1.0625)	0.2353**	(0.0620)	0.1240	(0.0719)	0.2839**	(0.0540)
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	1.3187**	(0.1090)	1.4110**	(0.1339)	0.9790**	(0.1173)	1.1660**	(0.0254)	1.1518**	(0.0358)	0.9435**	(0.0234)
N	32702		32702		32702		32458		32452		32465	
r2	0.0961		0.0555		0.1119		0.4468		0.2857		0.5497	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

ALL MODEL SUMMARY

Table 42 compares each of the final model specifications for the person-based GUMCADv2 (model 1); person-based GUMCADv2 and CTAD (model 2); and LSOA (GUMCADv2 and CTAD) all ages, under 25 and 25 and over groups (model 3).

The following needs variables are consistently significant (p-value<0.01) for all model specifications and may therefore be seen as reliable variables for weighting:

- Jobseekers Allowance rate
- Average household size
- Whether the individual resides in an area containing a GUM clinic
- Distance to GUM clinic

The following variables are largely consistent (in most models):

- IMD 2010 Environment
- Proportion black/Caribbean

The person-based GUMCADv2 and CTAD model contains each of the above variables, controls for past use, gender, and age and may be preferred for issues of parsimony and completeness. However, the GUMCADv2 and CTAD person-based model reflects the inability to capture lagged total use for individuals (hence the drop in the magnitude of the effects of being a user in the previous year). The GUMCADv2 and CTAD person-based model does however, identify that activity in CTAD is relatively higher for females and younger age groups.

COMPARISON OF EACH MODEL

TABLE 42 SEXUAL HEALTH: FINAL SPECIFICATIONS FOR EACH MODEL SPECIFICATION

	LSOA		LSOA <25		LSOA >=25		Person-based GUMCADv2 only		Person-based GUMCADv2 and CTAD	
IMD 2010 environment score	0.0021*	(0.0011)					0.0050**	(0.0005)	0.0069**	(0.0015)
Jobseekers allowance claimants (2010 rate)	7.7086**	(1.8841)	10.2738**	(1.8888)	5.1783**	(1.5031)	4.2746**	(0.5783)	27.4515**	(2.3129)
Average Household Size	-0.2434**	(0.0443)	-0.2699**	(0.0545)	-0.1662**	(0.0437)	-0.1662**	(0.0263)	-0.8827**	(0.0614)
Prop Black/Caribbean	0.8494*	(0.3645)			1.6607**	(0.3862)	3.4151**	(0.2167)	2.9728**	(0.4476)
Prop single					0.5951**	(0.1577)				
Prop same-sex civil partnership									93.5247**	(23.6625)
Patient 2012-13							37.3997**	(0.0868)	19.3933**	(0.0791)
Female							0.2627**	(0.0111)	2.4133**	(0.0282)
Age 0-14							-4.8936**	(0.0258)	-5.4805**	(0.0535)
Age 15-19							-0.7334**	(0.0358)	3.5931**	(0.1319)
Age 20-24							3.1554**	(0.0524)	6.0770**	(0.1266)
Age 35-44							-3.0633**	(0.0283)	-2.9461**	(0.0601)
Age 45-64							-4.1208**	(0.0259)	-4.6719**	(0.0534)
Age 65-99							-4.6577**	(0.0253)	-5.4975**	(0.0520)
Clinic	4.3933**	(0.8636)	4.2879**	(0.9011)	4.5254**	(1.0625)	24.5326**	(0.4683)	52.4674**	(0.8765)
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	1.3187**	(0.1090)	1.4110**	(0.1339)	0.9790**	(0.1173)	5.0637**	(0.0713)	5.7775**	(0.1667)
N	32702		32702		32702		2574306		2574478	
r2	0.0961		0.0555		0.1119		0.0822		0.0743	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

IMPACT ON THE NEEDS INDEX

To investigate the different effects each model could have on the needs index we calculated each model's needs index, in particular:

- Person-based GUMCADv2 and CTAD (model 2)
- LSOA all age (model 3)
- LSOA under 25
- LSOA 25 and over

The mean, minimum and maximum weights are given in Table 43. The correlation between each index is provided in Table 44.

A strong correlation exists for all except the under 25 index, this is not strongly correlated with the LSOA 25 and over model (model 3).

The distribution of the supply effects are provided in Figures 18-22.

TABLE 43 SEXUAL HEALTH: NEEDS INDEX FOR EACH MODEL

Needs Index (GUMCADv2 & CTAD model)	Obs	Mean	Std. Dev.	Min	Max
LSOA analysis	150	1.041176	0.243034	0.686262	1.758029
LSOA <25 analysis	150	1.030386	0.241929	0.675327	1.93372
LSOA >=25 analysis	150	1.055326	0.337648	0.642103	2.370111
Person-based	150	1.054709	0.324672	0.677568	2.237033

TABLE 44 SEXUAL HEALTH: CORRELATIONS BETWEEN THE NEEDS INDEX FOR EACH MODEL

	LSOA analysis	LSOA <25 analysis	LSOA >=25 analysis	Person-based
LSOA analysis	1.000			
LSOA <25 analysis	0.8012	1.0000		
LSOA >=25 analysis	0.9047	0.4774	1.0000	
Person-based	0.9650	0.6802	0.9400	1.0000

FIGURE 18 SEXUAL HEALTH: LSOA ALL AGES SUPPLY EFFECTS

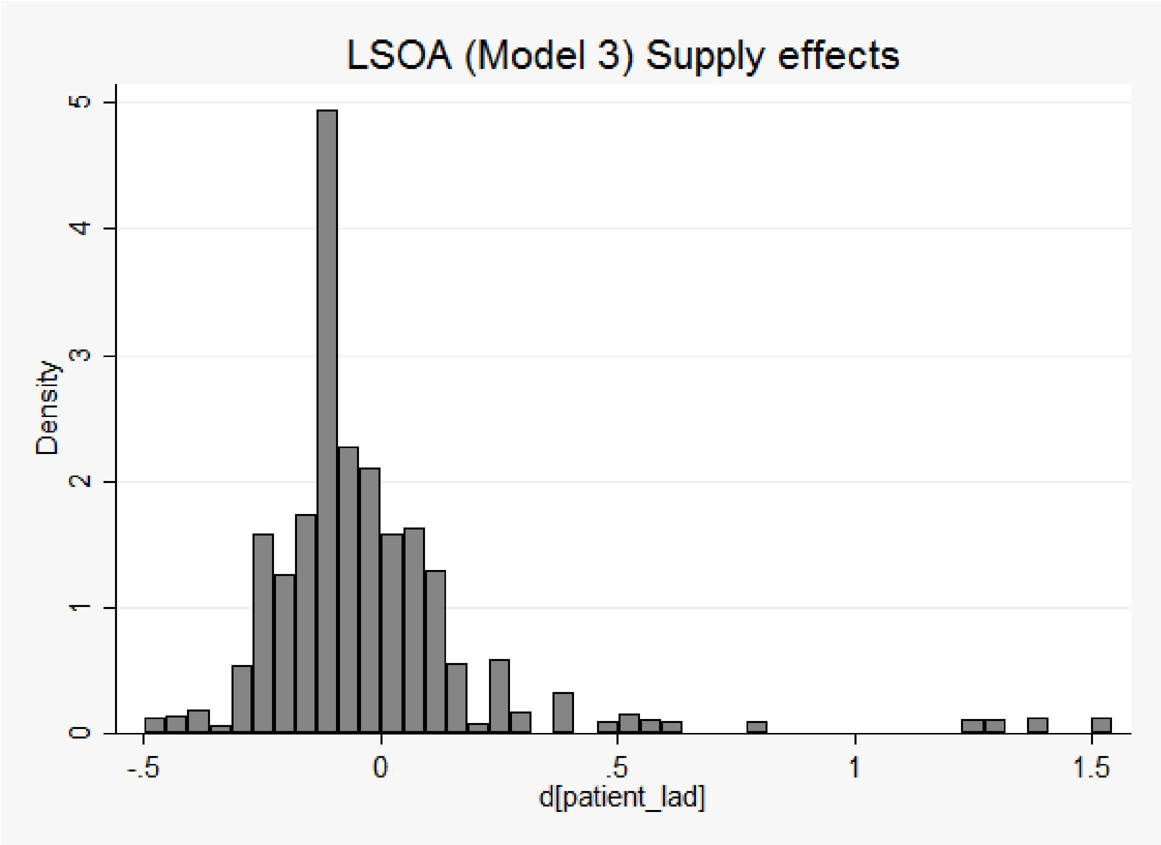


FIGURE 19 SEXUAL HEALTH: LSOA <25 SUPPLY EFFECTS

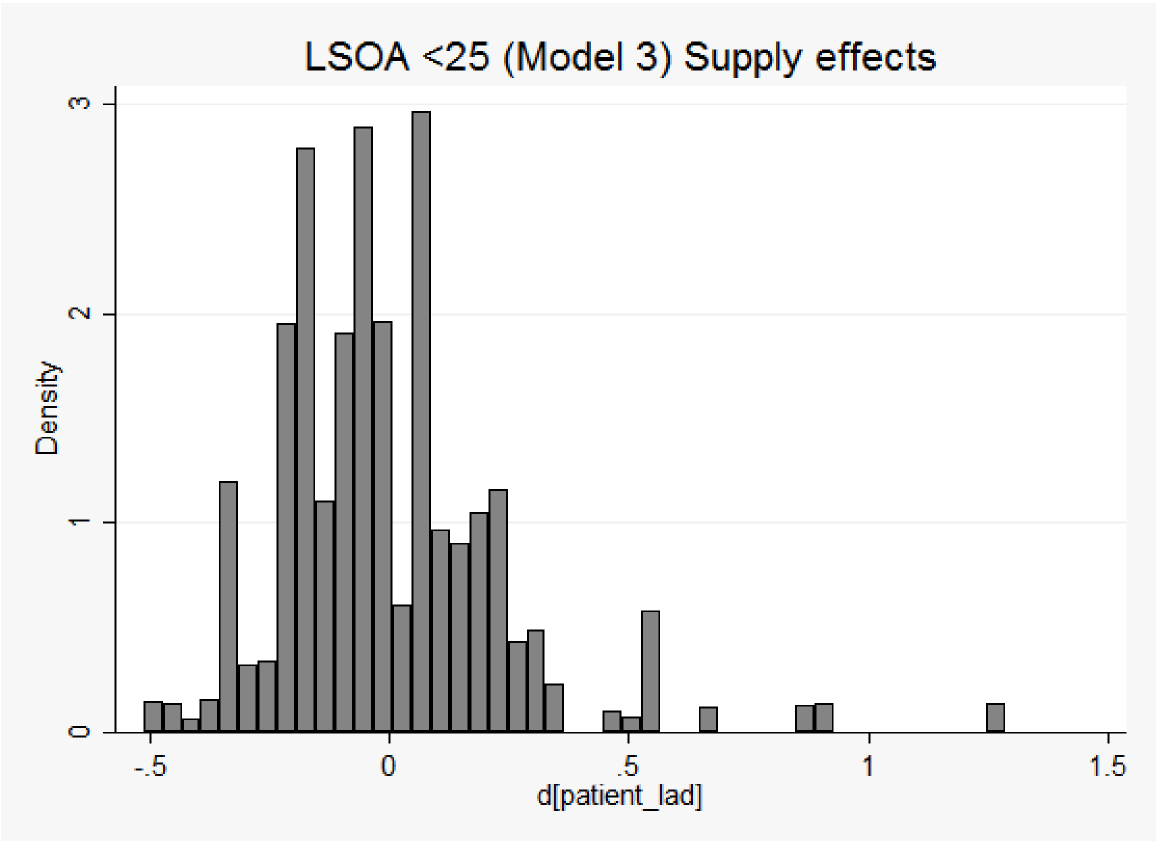


FIGURE 20 SEXUAL HEALTH: LSOA 25 AND OVER SUPPLY EFFECTS

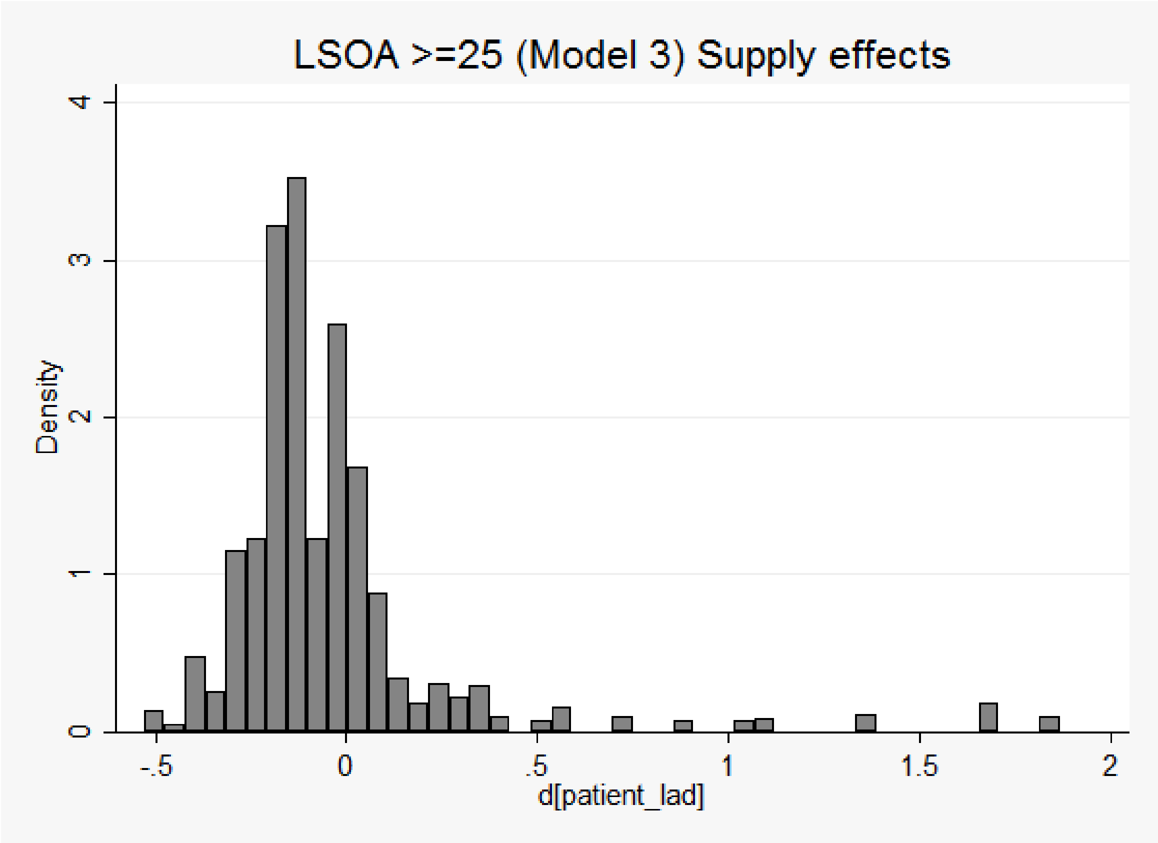


FIGURE 21 SEXUAL HEALTH: PERSON-BASED GUMCADV2 SUPPLY EFFECTS

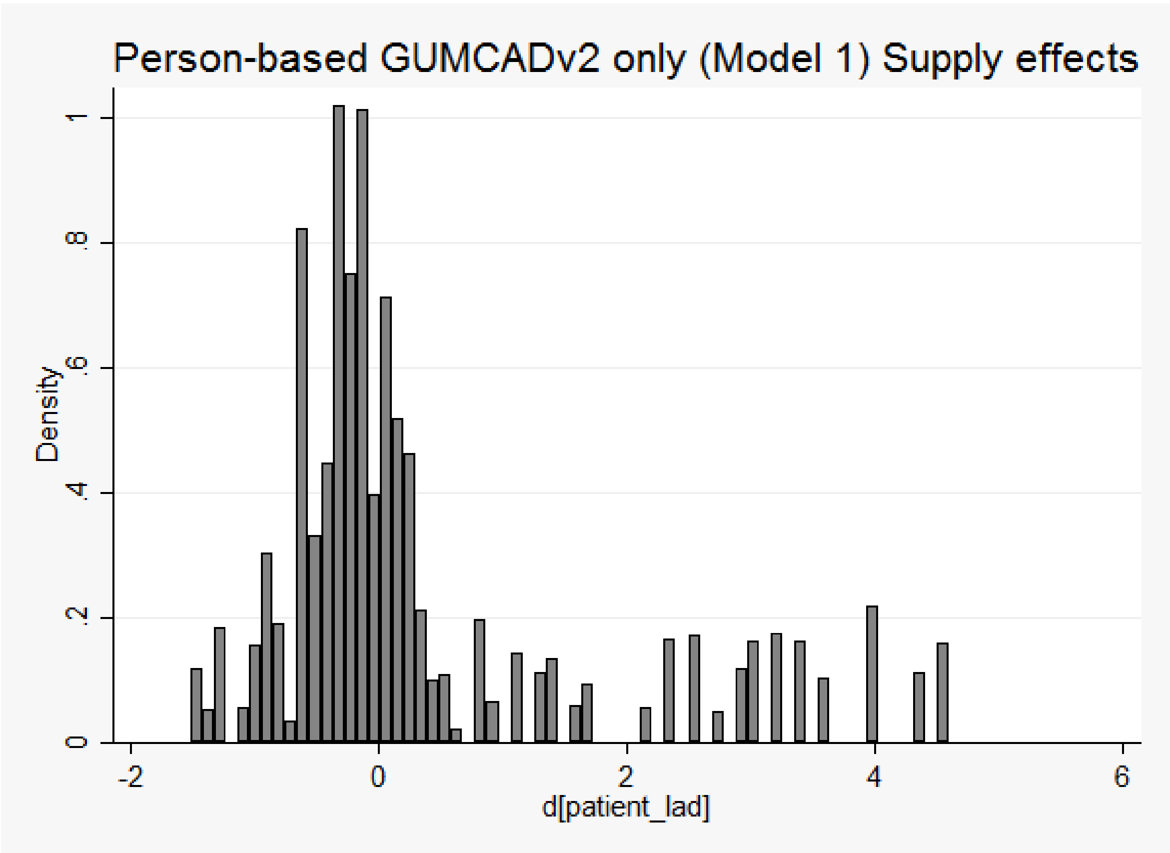
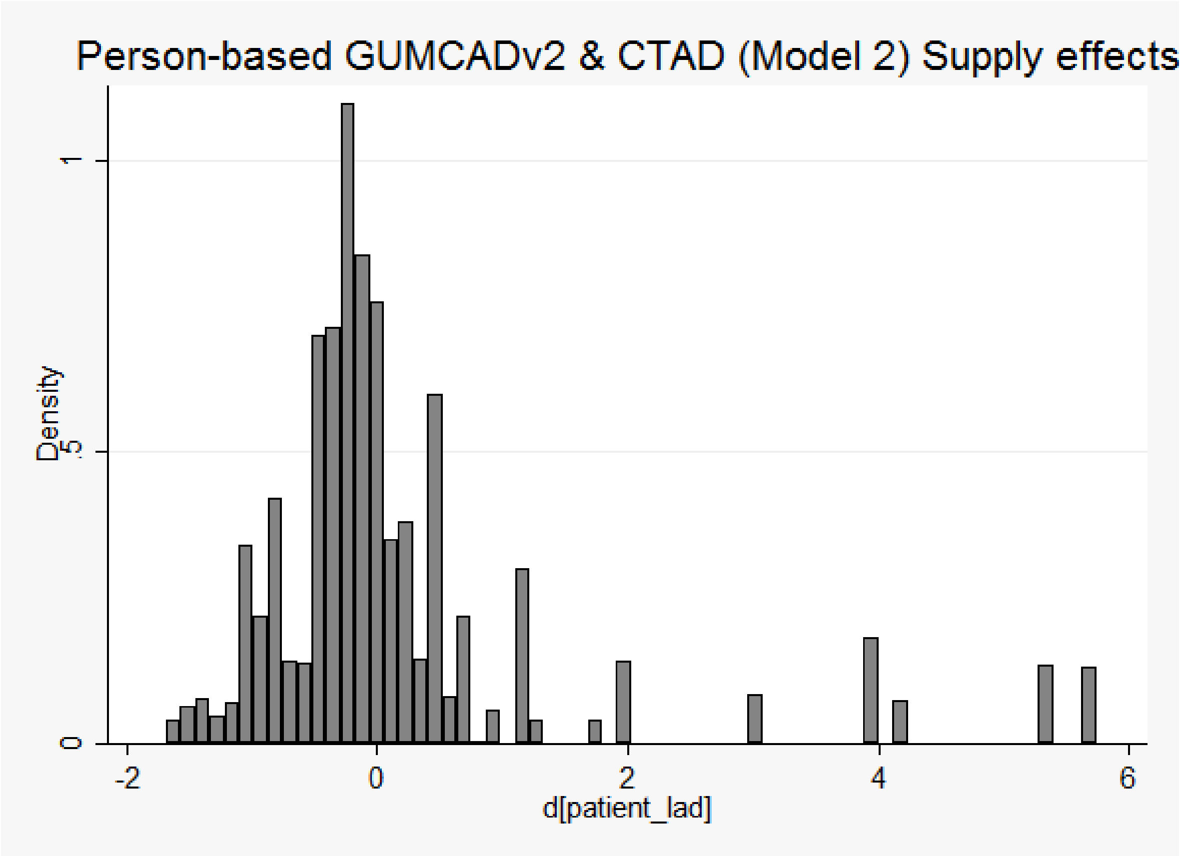


FIGURE 22 SEXUAL HEALTH: PERSON-BASED GUMCADV2 AND CTAD SUPPLY EFFECTS



MODEL RECOMMENDATION

On the basis of the importance of both incorporating lagged use in the person-based GUMCADv2 specification, and capturing sexual health services in CTAD; the most appropriate specification appears to be the person-based GUMCADv2 and CTAD model ('Person-based GUMCADv2 and CTAD' in Table 42). This model contains measures of need that are consistent across all model specifications, and generates an overall needs index that correlates well with the other model specifications.

ACRA expressed an interest in assessing the appropriateness of the clinic variable in the model, whilst initially thought of as a supply-side measure (having a provider of sexual health services in an area may lead to higher utilisation), this may also capture provider 'dumping' of patients for which no valid LSOA has been reported. In light of this we re-estimated the final specification of the person-based GUMCADv2 and CTAD model with the exclusion of the clinic variable (Table 45). Our results are largely robust.

TABLE 45 SEXUAL HEALTH: PERSON-BASED GUMCADV2 AND CTAD EXCLUDING CLINIC VARIABLE

	Person-based GUMCADv2 and CTAD		Person-based GUMCADv2 and CTAD (exc. Clinic)	
IMD 2010 environment score	0.0069**	(0.0015)	0.0070**	(0.0015)
Jobseekers allowance claimants (2010 rate)	27.4515**	(2.3129)	26.5750**	(2.3135)
Average Household Size	-0.8827**	(0.0614)	-1.0086**	(0.0614)
Prop Black/Caribbean	2.9728**	(0.4476)	3.0049**	(0.4479)
Prop single				
Prop same-sex civil partnership	93.5247**	(23.6625)	95.7596**	(23.6643)
Patient 2012-13	19.3933**	(0.0791)	20.2542**	(0.0799)
Female	2.4133**	(0.0282)	2.4102**	(0.0282)
Age 0-14	-5.4805**	(0.0535)	-5.5100**	(0.0536)
Age 15-19	3.5931**	(0.1319)	3.5923**	(0.1320)
Age 20-24	6.0770**	(0.1266)	6.1164**	(0.1267)
Age 35-44	-2.9461**	(0.0601)	-2.9657**	(0.0601)
Age 45-64	-4.6719**	(0.0534)	-4.7015**	(0.0534)
Age 65-99	-5.4975**	(0.0520)	-5.5338**	(0.0520)
Clinic	52.4674**	(0.8765)		
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	5.7775**	(0.1667)	6.1773**	(0.1667)
N	2574478		2574478	
r2	0.0743		0.0698	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

CONSIDERATION OF PREVENTION

To assess whether there may be an issue concerning prevention and sexual health testing/activity, we split the person-based GUMCADv2 and CTAD model (model 2) into tertiles (Table 46). The tertiles are constructed as the top, middle, and bottom third of LA's ranked by the proportion of sexual health spend on prevention (63/(61+62+63) in Table 2 by Local Authority). In general there appears no systematic relationship between modelled needs factors for sexual health activity and sexual health advice and prevention. To further assess the relationship we split costed activity in GUMCADv2 and CTAD into tertiles and assessed the correlation between both (Tables 47 compares the two groups). An overall correlation of 0.0191 was found. There is little evidence of a positive or negative relationship between sexual health activity and sexual health advice and prevention.

TABLE 46 SEXUAL HEALTH: FINAL MODEL SPECIFICATIONS FOR PERSON-BASED GUMCADV2 AND CTAD BY TERTILE OF PREVENTION SPEND

	Final		Tertile 1 (ave 2.1%)		Tertile 2 (ave 7.5%)		Tertile 3 (ave 30.0%)	
Patient 2012-13	19.3933**	(0.0791)	20.8911**	(0.1259)	18.5590**	(0.1480)	18.6338**	(0.1364)
Female	2.4133**	(0.0282)	2.3991**	(0.0439)	2.4763**	(0.0581)	2.3651**	(0.0456)
Age 0-14	-5.4805**	(0.0535)	-4.8963**	(0.0653)	-6.0237**	(0.1218)	-5.6394**	(0.0926)
Age 15-19	3.5931**	(0.1319)	3.3755**	(0.2318)	3.6267**	(0.2478)	3.8335**	(0.2018)
Age 20-24	6.0770**	(0.1266)	5.7258**	(0.2127)	6.3927**	(0.2468)	6.1680**	(0.1997)
Age 35-44	-2.9461**	(0.0601)	-2.6022**	(0.0705)	-3.2138**	(0.1372)	-3.0804**	(0.1058)
Age 45-64	-4.6719**	(0.0534)	-4.1955**	(0.0651)	-5.0581**	(0.1196)	-4.8564**	(0.0941)
Age 65-99	-5.4975**	(0.0520)	-4.9932**	(0.0654)	-5.9183**	(0.1152)	-5.6817**	(0.0910)
IMD (2010) Environment Score	0.0069**	(0.0015)	0.0152**	(0.0021)	0.0060	(0.0033)	-0.0008	(0.0027)
Jobseekers allowance claimant rate	27.4515**	(2.3129)	16.0461**	(2.9284)	51.0076**	(5.9045)	20.0986**	(3.3818)
Average household size	-0.8827**	(0.0614)	-0.9373**	(0.0912)	-0.9345**	(0.1586)	-0.8004**	(0.0874)
Proportion Black	2.9728**	(0.4476)	4.9845**	(0.7903)	-1.6052*	(0.7801)	6.1119**	(0.7858)
Proportion same-sex civil partnership	93.5247**	(23.6625)	-12.1924	(9.2498)	-1.1061	(11.3198)	271.3948**	(63.3335)
Clinic	52.4674**	(0.8765)	59.1653**	(2.2170)	95.1951**	(2.0167)	28.3361**	(0.8876)
Distance to clinic	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)	-0.0000**	(0.0000)
Constant	5.7775**	(0.1667)	5.6447**	(0.2479)	6.3375**	(0.3801)	5.5312**	(0.2839)
N	2574478		870219		867511		836748	
r2	0.0743		0.0686		0.0756		0.0849	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

TABLE 47 SEXUAL HEALTH: TABULATION OF LOCAL AUTHORITY TERTILES FOR SEXUAL HEALTH ACTIVITY (GUMCADV2 AND CTAD) AND PREVENTION SPEND

	Sexual health activity tertile			
Prevention tertile	**1**	**2**	**3**	**Total**
1	13	23	14	50
	26.00	46.00	28.00	100.00
2	17	15	19	51
	33.33	29.41	37.25	100.00
3	20	12	17	49
	40.82	24.49	34.69	100.00
Total	50	50	50	150
	33.33	33.33	33.33	100.00

FUTURE DEVELOPMENT OF THE SEXUAL HEALTH FORMULA

Whilst our models include data on sexual health service utilisation in GUM clinics and comprehensive coverage of all chlamydia testing, we were unable to obtain reliable SRHAD data which would enable the incorporation of services under the public health remit concerning sexual health and reproductive services in the community. We were also unable to model any activity provided outside of GUM clinics (aside from chlamydia). Improvements in data coverage are occurring and will provide opportunities to test and expand the methods taken within this report.

REPORT SUMMARY

RECOMMENDATIONS

The existing resource allocation formula for public health budgets was provisional and the work contained in this report was commissioned on the basis of providing a stronger evidence-based approach. Within this report we have refined and developed the SMR approach to population health (which comprised a significant proportion of the existing formula), and developed person-based models for drugs, alcohol, and sexual health service utilisation. The person-based models permit the ability to generate needs weights that are determined by statistical significance and can accommodate supply-side factors, these make substantial movement towards an evidence-based approach for the public health resource allocation formula.

POPULATION HEALTH

We considered the exponential of the rank transformations used in the current public health formula. This has the effect of compressing the range of allocations at both the lower and upper end of the distribution and we recommend that this transformation be discontinued. Our analysis produced simple models based on a small set of plausible variables that explained 83% of the variation in the SMR at MSOA level. These variables were also good predictors of variations in self-assessed health. Use of a modelled SMR could provide more stability in allocations and avoid the potential for a perverse incentive under which areas that improve health have subsequently reduced allocations. However, deviations of the modelled SMRs from the actual SMRs show a systematic pattern which suggests that causes of poor health with a marked regional pattern are absent from the model. Until variables that might explain this regional pattern are identified, we recommend continuing to use observed values of the SMR to make allocations.

DRUGS AND ALCOHOL

Our analysis considers drugs and alcohol treatment separately and combined; the alcohol-only model performs less well. We present three sets of models: an age-standardised model; an age-stratified model; and a person-based model. The age-stratified model performs poorly for the under-18 age group. The person-based model permits the use of a wider range of predictor variables than that possible with the age-standardised model, in particular, very strong predictors such as past-year treatment history. For these reasons, we recommend the use of a person-based model of drug and alcohol services combined.

SEXUAL HEALTH

Our analysis comprises of a comprehensive assessment of data availability, identifies the most complete and up to date utilisation data (GUMCADv2 and CTAD) and is the first resource allocation formula for sexual health services that employs a person-based approach. The ability to perform a person-based model highlights significant persistence in sexual health use. Our models also highlight the importance of incorporating CTAD activity in the formula. On the evidence we therefore recommend the GUMCADv2 and CTAD person-based model (Table 45). Our analysis finds that this model has plausible needs and supply variables, is robust to a variety of sensitivity checks, correlates well with the alternatives, and has good explanatory power.

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APPENDIX

TABLE A 1 POPULATION HEALTH: MEAN & STANDARD DEVIATION FOR EXPLANATORY VARIABLES

Variable	Mean	Std. Dev.
Income Score 2010	0.147	0.094
Air pollution	0.965	0.252
% Prof/Scientific	6.419	3.545
% 17+ leaving educ	0.607	0.167
% Families rec. WTCs	76.162	9.374
% Population rec. JSA	2.367	1.805
Inward Migration Aged 15-24	119.328	54.800
Inward Migration Aged 45-64	44.272	15.864
Inward Migration Aged 65+	29.461	15.830
Outward Migration Aged 45-64	45.137	16.753
Outward Migration Aged 65+	31.023	10.489
% Occupied homes without central heating	0.027	0.018
% Occupied homes with < two bedrooms	0.389	0.144
Number of CCJs in 2005	110.613	70.930

TABLE A 2 POPULATION HEALTH: CORRELATION MATRIX OF EXPLANATORY VARIABLES

	Income Score 2010	Air pollution	% Prof Scientific	% 17+ leaving educ	% Families rec. WTCs	% Population rec. JSA	Migration In 15-24	Migration In 45-64	Migration In 65+	Migration Out 45-64	Migration Out 65+	% Occupied homes without central heating	% Occupied homes with < two bedrooms	CCJs in 2005
Income Score 2010	1.000													
Air pollution	0.406	1.000												
% Prof/Scientific	-0.569	0.051	1.000											
% 17+ leaving educ	0.624	0.021	-0.795	1.000										
% Families rec. WTCs	-0.773	-0.592	0.174	-0.322	1.000									
% Population rec. JSA	0.928	0.478	-0.533	0.561	-0.726	1.000								
Migration In 15-24	0.278	0.194	0.035	0.018	-0.367	0.286	1.000							
Migration In 45-64	0.340	0.096	-0.028	0.036	-0.330	0.288	0.646	1.000						
Migration In 65+	0.023	-0.092	0.056	-0.084	-0.016	-0.013	0.292	0.412	1.000					
Migration Out 45-64	0.454	0.370	-0.019	0.059	-0.522	0.428	0.626	0.695	0.288	1.000				
Migration Out 65+	0.302	0.233	0.065	-0.030	-0.360	0.268	0.422	0.521	0.229	0.609	1.000			
% Occupied homes without central heating	0.356	0.166	-0.131	0.147	-0.235	0.345	0.319	0.386	0.086	0.421	0.320	1.000		
% Occupied homes with < two bedrooms	0.584	0.389	-0.106	0.216	-0.591	0.551	0.540	0.560	0.227	0.595	0.422	0.436	1.000	
CCJs in 2005	0.804	0.383	-0.538	0.567	-0.649	0.777	0.305	0.309	0.029	0.443	0.264	0.341	0.521	1.000

TABLE A 3 DRUGS AND ALCOHOL: CORRELATION BETWEEN PREDICTOR VARIABLES: DRUG AND ALCOHOL MISUSE MODEL. ALL AGES, 2013/14 DATA

	SMR	IMD Crime	Population turnover	Prop white British	Proportion Male	IMD Income	IMD Environment	GP Prescribing	Distance	Waiting time
SMR [a]	1.000									
IMD Crime	0.656	1.000								
Population turnover [b]	0.447	0.542	1.000							
Proportion white British	-0.262	-0.482	-0.567	1.000						
Proportion male	0.176	0.180	0.274	-0.320	1.000					
IMD Income	0.675	0.532	0.370	-0.364	0.075	1.000				
IMD Environment	0.368	0.357	0.449	-0.447	0.245	0.453	1.000			
Proportion GP prescribing	0.045	0.041	0.027	-0.006	-0.014	0.035	0.009	1.000		
Distance to nearest service [c]	-0.348	-0.511	-0.361	0.380	-0.132	-0.279	-0.151	-0.019	1.000	
Mean waiting time	-0.099	-0.159	-0.110	0.167	-0.040	-0.094	-0.073	-0.016	0.196	1.000

Notes: [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service.

TABLE A 4 DRUGS AND ALCOHOL: REGRESSION MODELS: DRUG AND ALCOHOL MISUSE. ALL AGES, 2013/14 DATA INCORPORATING ADDITIONAL ETHNIC CATEGORIES

Variable	model
SMR [a]	0.015**
	[0.001]
IMD Crime	0.407**
	[0.024]
Population turnover [b]	0.005**
	[0.001]
Proportion white other	-1.540
	[1.221]
Proportion mixed ethnicity	-6.390**
	[1.736]
Proportion Asian	-1.154**
	[0.189]
Proportion Black	-2.111**
	[0.381]
Proportion other ethnic group	-4.079**
	[1.284]
Proportion male	3.713**
	[0.825]
IMD Income	0.612**
	[0.119]
IMD Environment	0.002**
	[0.001]
Proportion of GP prescribing	-0.562**
	[0.051]
Distance to nearest service [c]	-0.010**
	[0.002]
Mean waiting time	-0.002
	[0.001]
Constant	-2.647
	[0.407]
Number of areas	9366
Adj R-squared	0.522

Notes: * $p < 0.05$. ** $p < 0.01$. Reference category is white British. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

Table A4 shows that all of the ethnic categories, apart from white other, are significant predictors in the model but their incorporation does not increase the adjusted R-squared statistic.

TABLE A 5 DRUGS AND ALCOHOL: REGRESSION MODELS. ALL AGES, 2013/14 DATA FOR ALL TREATMENT CASES AND RESTRICTED TO INCIDENT CASES

Drug and alcohol			**Drug misuse**			**Alcohol misuse**		
variable	Prevalent cases	Incident cases	variable	Prevalent cases	Incident cases	variable	Prevalent cases	Incident cases
SMR [a]	0.015**	0.014**	SMR [a]	0.016**	0.002**	SMR [a]	0.011**	0.369**
	[0.001]	[0.001]		[0.001]	[0.000]		[0.001]	[0.024]
IMD Crime	0.389**	0.311**	IMD Crime	0.410**	0.023**	IMD Crime	0.273**	7.965**
	[0.024]	[0.035]		[0.026]	[0.007]		[0.030]	[0.972]
Population turnover [b]	0.006**	0.0001	Population turnover [b]	0.005**	0.00004	Population turnover [d]	0.007**	0.028
	[0.001]	[0.001]		[0.001]	[0.000]		[0.001]	[0.015]
Proportion white British	0.829**	1.518**	Proportion white British	0.828**	0.086**	IMD Mood & Anxiety	0.128**	3.506**
	[0.093]	[0.122]		[0.100]	[0.026]		[0.022]	[0.660]
Proportion male	4.189**	1.338	Proportion male	4.233**	0.542**	Proportion male	3.953**	10.914
	[0.862]	[0.941]		[0.891]	[0.201]		[1.095]	[25.214]
IMD Income	0.631**	0.224	IMD Income	0.723**	0.026	Proportion white British	0.669**	35.320**
	[0.119]	[0.162]		[0.130]	[0.035]		[0.108]	[3.230]
IMD Environment	0.003**	0.003**	IMD Environment	0.003**	0.0004	IMD Environment	0.004**	0.051
	[0.001]	[0.001]		[0.001]	[0.000]		[0.001]	[0.031]
Proportion of GP prescribing	-0.571**	0.150	Proportion of GP prescribing	-0.601**	0.010	Proportion of GP prescribing	-0.233**	4.083
	[0.051]	[0.089]		[0.050]	[0.017]		[0.063]	[2.428]
Distance to nearest service [c]	-0.01**	-0.016**	Distance to nearest service [c]	-0.011**	-0.001**	Distance to nearest service [c]	-0.007*	-0.376**
	[0.002]	[0.004]		[0.002]	[0.000]		[0.003]	[0.104]
Mean waiting time	-0.002	-0.006*	Mean waiting time	0.001	-0.0003	Mean waiting time	-0.003*	-0.149**
	[0.001]	[0.002]		[0.001]	[0.000]		[0.001]	[0.052]
Constant	-3.747	-1.948	Constant	-3.856	-0.432	Constant	-3.098	-34.390
	[0.463]	[0.510]		[0.481]	[0.111]		[0.580]	[13.628]
Number of areas	9366	9366	Number of areas	9366	9366	Number of areas	9366	9366
Adj R-squared	0.522	0.312	Adj R-squared	0.513	0.121	Adjusted R-squared	0.334	0.318

Notes: * $p < 0.05$. ** $p < 0.01$. [a] Standardised Mortality Ratio. [b] Outflow rate all ages: rate per 1000 (2009-10). [c] Distance (km) from post sector centroid to post code of the nearest treatment service. [d] Inflow rate all ages: rate per 1000 (2009-10). The dependent variable is the indirectly-standardised cost ratio. Unit of observation is the postcode sector/local authority combination. Robust standard errors in [ ]. All models account for UTLA. Shaded cells are models using additional supply variables.

TABLE A 6 SEXUAL HEALTH: COMPLEX LSOA 2001 TO 2011 CHANGES

LSOA01CD	LSOA01NM	LSOA11CD	LAD11NM
E01012004	Hartlepool 003E	E01032541	Hartlepool
E01012006	Hartlepool 003F	E01032541	Hartlepool
E01011956	Hartlepool 003B	E01033466	Hartlepool
E01011958	Hartlepool 003D	E01033466	Hartlepool
E01012086	Middlesbrough 018E	E01032552	Middlesbrough
E01012087	Middlesbrough 018F	E01032553	Middlesbrough
E01012072	Middlesbrough 016E	E01032593	Middlesbrough
E01012103	Redcar and Cleveland 003A	E01032560	Redcar and Cleveland
E01012104	Redcar and Cleveland 003B	E01032561	Redcar and Cleveland
E01012123	Redcar and Cleveland 019B	E01032548	Redcar and Cleveland
E01012125	Redcar and Cleveland 019C	E01032548	Redcar and Cleveland
E01012126	Redcar and Cleveland 019D	E01032549	Redcar and Cleveland
E01012122	Redcar and Cleveland 019A	E01033472	Redcar and Cleveland
E01012153	Redcar and Cleveland 017E	E01032594	Redcar and Cleveland
E01012220	Stockton-on-Tees 009A	E01032542	Stockton-on-Tees
E01012221	Stockton-on-Tees 009B	E01032543	Stockton-on-Tees
E01012222	Stockton-on-Tees 009C	E01032544	Stockton-on-Tees
E01012321	Darlington 002A	E01032545	Darlington
E01012322	Darlington 002B	E01032546	Darlington
E01012627	Blackburn with Darwen 018C	E01032485	Blackburn with Darwen
E01012626	Blackburn with Darwen 018B	E01032486	Blackburn with Darwen
E01012885	Kingston upon Hull 032D	E01032595	Kingston upon Hull, City of
E01013109	East Riding of Yorkshire 030F	E01032596	East Riding of Yorkshire
E01013769	Leicester 014E	E01032597	Leicester
E01013708	Leicester 033D	E01032599	Leicester
E01013724	Leicester 015B	E01032602	Leicester
E01013949	Nottingham 028A	E01032520	Nottingham
E01013952	Nottingham 028D	E01032520	Nottingham
E01013950	Nottingham 028B	E01033404	Nottingham
E01013951	Nottingham 028C	E01033404	Nottingham
E01013848	Nottingham 003A	E01032621	Nottingham
E01014604	Bristol 001D	E01032516	Bristol, City of
E01014606	Bristol 001F	E01032517	Bristol, City of
E01014625	Bristol 018B	E01032518	Bristol, City of
E01014628	Bristol 018C	E01032519	Bristol, City of
E01014724	Bristol 053A	E01032514	Bristol, City of
E01014728	Bristol 053D	E01032515	Bristol, City of
E01017065	Portsmouth 005C	E01032604	Portsmouth
E01017772	Chiltern 009A	E01032609	Chiltern
E01017879	Wycombe 005A	E01032610	Wycombe
E01018018	East Cambridgeshire 010B	E01032611	East Cambridgeshire
E01019466	Amber Valley 014E	E01032613	Amber Valley
E01019637	Erewash 002A	E01032614	Erewash
E01019789	North East Derbyshire 003A	E01032586	North East Derbyshire
E01022609	East Hampshire 015A	E01032615	East Hampshire

E01022612	East Hampshire 015C	E01032616	East Hampshire
E01022598	East Hampshire 005A	E01032625	East Hampshire
E01022912	Havant 012F	E01032605	Havant
E01022932	Havant 001B	E01032618	Havant
E01022923	Havant 002D	E01032617	Havant
E01024412	Sevenoaks 006A	E01032619	Sevenoaks
E01024739	Tonbridge and Malling 004B	E01032620	Tonbridge and Malling
E01024738	Tonbridge and Malling 004A	E01032829	Tonbridge and Malling
E01025628	Blaby 001D	E01032603	Blaby
E01025811	Harborough 001A	E01032598	Harborough
E01025996	Oadby and Wigston 004B	E01032600	Oadby and Wigston
E01026002	Oadby and Wigston 004C	E01032601	Oadby and Wigston
E01028145	Gedling 003B	E01032622	Gedling
E01028590	Oxford 002B	E01032554	Oxford
E01028589	Oxford 002A	E01032555	Oxford
E01028593	Oxford 002E	E01032555	Oxford
E01029931	Forest Heath 003A	E01032523	Forest Heath
E01029932	Forest Heath 003B	E01032524	Forest Heath
E01029933	Forest Heath 003C	E01032525	Forest Heath
E01029934	Forest Heath 003D	E01032526	Forest Heath
E01029924	Forest Heath 007A	E01032612	Forest Heath
E01030397	Epsom and Ewell 006E	E01032624	Epsom and Ewell
E01030849	Tandridge 001A	E01032571	Tandridge
E01030936	Waverley 014F	E01032626	Waverley
E01031076	Nuneaton and Bedworth 017A	E01032588	Nuneaton and Bedworth
E01005425	Oldham 007A	E01032558	Oldham
E01005426	Oldham 007B	E01032559	Oldham
E01005384	Oldham 026B	E01032556	Oldham
E01005385	Oldham 026C	E01032557	Oldham
E01006733	Liverpool 008D	E01032510	Liverpool
E01006789	Liverpool 008E	E01032511	Liverpool
E01006714	Liverpool 027B	E01032508	Liverpool
E01006715	Liverpool 027C	E01032509	Liverpool
E01006631	Liverpool 050A	E01032505	Liverpool
E01006635	Liverpool 050D	E01032506	Liverpool
E01006636	Liverpool 050E	E01032507	Liverpool
E01007401	Barnsley 010A	E01032550	Barnsley
E01007407	Barnsley 010B	E01032550	Barnsley
E01007412	Barnsley 010F	E01032551	Barnsley
E01008026	Sheffield 067E	E01032585	Sheffield
E01008794	Sunderland 032C	E01032483	Sunderland
E01008798	Sunderland 032E	E01032484	Sunderland
E01009038	Birmingham 114A	E01032589	Birmingham
E01009277	Birmingham 027D	E01032591	Birmingham
E01009600	Coventry 001B	E01032536	Coventry
E01009602	Coventry 001D	E01032537	Coventry
E01009601	Coventry 001C	E01032538	Coventry
E01009603	Coventry 001E	E01032538	Coventry

E01009533	Coventry 035A	E01032527	Coventry
E01009534	Coventry 035B	E01032528	Coventry
E01009675	Coventry 036A	E01032531	Coventry
E01009677	Coventry 036B	E01032532	Coventry
E01009680	Coventry 036D	E01032533	Coventry
E01009545	Coventry 037A	E01032534	Coventry
E01009551	Coventry 037D	E01032535	Coventry
E01009546	Coventry 038B	E01032529	Coventry
E01009547	Coventry 038C	E01032530	Coventry
E01009595	Coventry 003C	E01032587	Coventry
E01009945	Sandwell 008A	E01032592	Sandwell
E01010224	Solihull 020C	E01032590	Solihull
E01011575	Leeds 007B	E01032503	Leeds
E01011577	Leeds 007D	E01032504	Leeds
E01011387	Leeds 017C	E01032501	Leeds
E01011389	Leeds 017D	E01032502	Leeds
E01011486	Leeds 033C	E01032493	Leeds
E01011487	Leeds 033D	E01032494	Leeds
E01011289	Leeds 067D	E01032499	Leeds
E01011290	Leeds 067E	E01032500	Leeds
E01011285	Leeds 067A	E01032606	Leeds
E01011288	Leeds 067C	E01032606	Leeds
E01011291	Leeds 067F	E01032607	Leeds
E01011631	Leeds 097A	E01032487	Leeds
E01011640	Leeds 097E	E01032488	Leeds
E01011501	Leeds 099B	E01032497	Leeds
E01011503	Leeds 099D	E01032498	Leeds
E01011539	Leeds 102A	E01032489	Leeds
E01011542	Leeds 102C	E01032490	Leeds
E01011543	Leeds 102D	E01032491	Leeds
E01011544	Leeds 102E	E01032492	Leeds
E01011495	Leeds 105A	E01032495	Leeds
E01011498	Leeds 105B	E01032496	Leeds
E01000026	Barking and Dagenham 005C	E01032580	Barking and Dagenham
E01000397	Bexley 012A	E01032566	Bexley
E01000817	Bromley 003B	E01032562	Bromley
E01000821	Bromley 003E	E01032563	Bromley
E01000776	Bromley 017E	E01032568	Bromley
E01000660	Bromley 038B	E01032570	Bromley
E01000988	Croydon 012A	E01032569	Croydon
E01001378	Ealing 036C	E01032572	Ealing
E01001561	Enfield 034D	E01032574	Enfield
E01001670	Greenwich 013B	E01032567	Greenwich
E01001643	Greenwich 018F	E01033746	Greenwich
E01002035	Haringey 003B	E01032575	Haringey
E01002205	Harrow 026B	E01032576	Harrow
E01002500	Hillingdon 012E	E01032577	Hillingdon
E01002688	Hounslow 002B	E01032573	Hounslow

E01003012	Lambeth 001A	E01032582	Lambeth
E01003242	Lewisham 032E	E01032564	Lewisham
E01003234	Lewisham 036A	E01032565	Lewisham
E01003306	Lewisham 004E	E01032579	Lewisham
E01003717	Redbridge 028E	E01032581	Redbridge
E01003928	Southwark 005A	E01032583	Southwark
E01003931	Southwark 005C	E01032584	Southwark
E01004113	Sutton 023D	E01032623	Sutton
E01004758	Westminster 010D	E01032512	Westminster
E01004759	Westminster 010E	E01032513	Westminster