**An investigation of social, demographic and health variations in the usage of prescribed and over-the-counter medicines within a large cohort (South Yorkshire, UK)**

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**Abstract**

Objectives: Prescribed and over-the-counter (non-prescribed) medicine usage has increased in recent years, however there has been less investigation of the socio-economic predictors of use. This has been due to a lack of data, especially for over-the-counter medicines. Our study aims to understand how prescribed and over-the-counter medicine patterns vary by demographic, social and health characteristics within a large population cohort.

Design: Cross-sectional data analysis.

Setting: South Yorkshire, UK.

Participants: 27,806 individuals from wave one of the Yorkshire Health Study (2010-2012).

Measures: Individuals self-reported each medicine they were taking and whether each was prescribed or not. The medicines were grouped into 14 categories (e.g. cardiovascular system, infection, contraception). Negative binomial regression models were used to analyse the count of medicine usage. We included demographic (age, gender, ethnicity), social (education), health-related (body mass index, smoking, alcohol consumption, physical activity) factors and chronic health conditions (e.g. stroke, anxiety and heart disease) in our analyses.

Results: 49 per cent of males and 62 per cent of females were taking medicine with the majority of this prescribed (88 per cent and 83 per cent respectively). Health conditions were found to be positively associated with prescribed medicine usage, but mixed in their associated with over-the-counter medicines. Educational attainment was negatively associated with prescribed and positively associated with over-the-counter usage.

Conclusions: Our study addresses a dearth of evidence to provide new insights into how behaviours in medicine usage vary by demographic, social and health-related factors. Differences in over-the-counter medicine usage by educational attainment may help our understanding of the determinants of health inequalities.

**MeSH Keywords**

Medicine; Education; Prescriptions.

**Strengths and limitations of this study**

* We address a dearth of evidence on socio-economic differences in terms of prescribed and over-the-counter (non-prescribed) medication usage (disaggregated by medicine type) using a large secondary dataset.
* Our data are self-reported and may be subject to bias suggesting the need for objective data.
* Our analysis is only cross-sectional and extending this investigation longitudinally will be necessary for assessing the importance of our results.

**Introduction**

There have been recognised increases in the production, affordability and consumption of medicines globally for many years (1), reflecting a market of several hundreds of billions of pounds. In England, for example, the total volume of medicine taken across England has grown with the total number of medicines prescribed by General Practitioners (GPs) tripling in the 15 years up to 2010 (2). This growth has occurred during a period of rising life expectancy, quality of life and better health care.

Over-the-counter (i.e. non-prescribed and not funded by the state) medicines represent the other key supply route, and this also represents a significant market, with over nine hundred million packs being supplied in the UK in 2011 (3). Indeed, the cost of medicines has been the subject of increasing attention, where it represents a key burden in health care systems like the National Health System (NHS) in the UK. Over-the-counter medicine use has been argued to represent a potential saving by reducing NHS spending by shifting the financial burden to individuals (4). However, the approach also follows a wider NHS strategy to enhance patient’s empowerment through promoting self-medication contrary to other European nations (5–7).

Previous research into predictors of medicine usage have focused on demographic factors particularly age and gender. Prescribed medication usage has been shown to increase with age due to the association between ill health and age (8–11), although childhood and adolescence also represent important focal points of research (12,13). In contrast, over-the-counter medicine usage decreases with age (9,11,14). Differences in terms of gender have also been explored extensively, with females consistently found to use greater prescribed and over-the-counter medicines (9–11,14–16). Women are more health conscious than men, and have greater interactions with health care systems, which might explain these differences (17). There has also been some investigation of gender inequity in medication usage in low- and medium-income countries (17,18).

There have been fewer studies that have explored the influence of social determinants on medicine usage, particularly for over-the-counter medicines. This is despite a more extensive literature on social inequalities in health, health-related behaviours and health service usage (19). Inconsistent findings have been reported for patterns by prescribed medicines usage although this appears dependent on the policy context (9–12,15,20,21). The association for over-the-counter medicine utilisation appears clearer, with greater usage among individuals of higher social standing (9,11,14,21). However, there has been less investigation of the social determinants of over-the-counter medicine due to a lack of available data. Understanding differences in medicine utilisation is important in explaining the existence of social inequalities in health.

There has been less investigation of population-level associations within the UK, with most of the evidence base conducted in the US. This has been due to a lack of available data, particularly for over-the-counter medicines which represent important areas due to their potential benefits (saving GP time and NHS costs) and problems (medicine interactions, side effects, misuse and abuse; (22)). Data sources often contain small sample sizes, restricting the generalisability of findings. Whilst the Health Survey of England is the largest national survey on health behaviours in England, it only contains information on prescribed medicines (23). There has also been a concentration of research exploring uptake of cardiovascular medicine (24,25), ignoring potential variations in other types of medicines.

Our study aims to understand how prescribed and over-the-counter medicine patterns vary by demographic, social and health characteristics within a large population cohort. We also disaggregate our analyses by medicine type.

**Methods**

*Data*

Data were taken from the first wave (2010-2012) of the Yorkshire Health Study (formerly the South Yorkshire Cohort), a longitudinal observational survey (26). The first wave contained information on 27,806 individuals aged 16 and over that consisted of the South Yorkshire region of England. Data were self-reported by individuals. Records with missing medicine data were dropped leaving a total analytical sample of 18,272.

Individuals were asked to record any medicines they were currently taking, including whether it was prescribed or not. The data were then grouped into 14 categories (linked to the British National Formulary (BNF)), loosely based upon the area and organ system of the body being targeted by the medicine (see Table 1). This grouping system was selected to minimise overlap between categories and follows previous research (8). Names of groups follow the BNF other than ‘Malignant disease’ medication which we refer to as ‘chemotherapy/immunosuppressant’ as it is a more useful descriptor. We separated both oral contraceptives and diabetes medicine from other endocrine system agents. Oral contraceptives were considered separately to be able to explore gender variations in endocrine system medicine usage (16). Diabetes medicines were also separated due to their high prevalence and relative importance in public health decision making.

Demographic factors included in our analysis were age, gender and ethnicity since variations in medicine use with respect to these factors have been previously demonstrated (9,10,14,27). Age was measured as a continuous variable (in years) and gender was measured as a binary variable (male or female). Ethnicity was dichotomised into White or Non-White. We did not disaggregate the Non-White category further due to the lack of heterogeneity in the sample (i.e. 5.9% of the sample were Non-White).

Education was the only social measure included. Education has been used as a proxy for socio-economic status in previous research of medicine usage (10,11,20,21), since a higher level of education allows individuals to access better employment opportunities and therefore maximise their socio-economic status (28,29). Education also captures human capital which may influence health-related behaviours through greater cognitive ability to engage with health promotion resources. Education was defined using the following groups (European Qualifications Framework (EQF) level provided); ‘no formal education’ (EQF level 1), ‘secondary level of education’ (GCSE (General Certificate of Secondary Education) level or equivalent; EQF level 2-3), ‘post-secondary level’ (A-level or equivalent; EQF level 4), and ‘degree level or higher’ (EQF level 5+).

Heath-related behaviours were captured using body weight, smoking, alcohol and physical activity behaviours. Body mass index (BMI) was used as a measure of relative body weight since it has been shown to be positively associated with medicine usage (30). BMI is calculated by dividing an individual’s weight (kg) by their height squared (m2). Smoking status, alcohol consumption and physical activity level were all included since they are important predictors of health (31–37). Smoking status refers to whether an individual currently smokes or not. Alcohol consumption was measured as the number of units of alcohol consumed per week. Physical activity was measured using two variables; level of walking and level of physical exercise (e.g. sport, gym). Each measure was categorised as; ‘none’, ‘less than 1 hour’, ‘1 to 3 hours’, or ‘more than 3 hours’ per week.

We also examined the role of 12 chronic health conditions. Individuals reported whether they had any of the following long-standing conditions or disabilities; fatigue, pain, insomnia, anxiety, depression, diabetes, breathing problems (e.g. chronic bronchitis), high blood pressure, heart disease, osteoarthritis, stroke or cancer. These were each individually included as explanatory variables.

Each GP (General Practitioner) practice was included as a separate variable in the analysis in order to account for differences in prescribing patterns between surgeries (results not reported due to the large number of surgeries) (20).

*Statistical Analysis*

Prevalence of each medicine category was reported and weighted using sample weights. Weighting was necessary because the Yorkshire Health Study contains some bias since it is over-representative of the elderly, females, and individuals from affluent areas (26). Weighting allowed us to correct for known bias (sample weights were not used in the regression models). Analysis of medicine usage was conducted using total medicines split by prescription status. Medicine data were considered to have a Poisson distribution, however variances were greater than mean values. To account for the over dispersion, negative binomial regression models were used to analyse medicine usage. Incidence rate ratios (IRR) and their 95% Confidence Intervals (CIs) were reported. All explanatory variables were included in each multivariate model. GP practice could not be included as a random effect in the model since it resulted in the model becoming unstable and unable to converge. The analysis was also repeated for individual medicine categories to explore differences between them. Only the most prevalent medicine types (a sample size greater than 10%; Table 1) were selected to avoid small sample size issues. All analyses were undertaken using STATA/SE 13.0.

**Results**

Table 1 presents a summary of self-reported medicines taken split by category and gender. A greater proportion of females (62.2%) were found to be taking any category of medicine in comparison to males (49.3%). However, there was little difference in the mean number of any medicine category taken. Cardiovascular system medicines were the most common medicine taken, with gastro-intestinal system, CNS (Central Nervous System), CNS Pain and dietary supplements also commonly used. There was little difference in the mean number of medicines taken split by category or gender. The majority of medicines taken were prescribed, however the proportion prescribed varied by category. Dietary supplements were the only category with greater over-the-counter medicines than prescribed medicines.

**Table 1:** Summary statistics on medicine usage including the percentage of each category taken, the mean number taken and the percentage of each prescribed (n=18,272).

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Individuals taking each medicine (%)** | **Mean number of medicines taken+** | **Percentage of medicines prescribed (%)** |
| **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| Cardiovascular system | 24.3 | 21.3 | 2.7 | 2.4 | 97.7 | 97.0 |
| Gastro-intestinal system | 12.1 | 14.6 | 1.2 | 1.3 | 94.9 | 92.4 |
| CNS (Central Nervous System) | 9.6 | 16.0 | 1.3 | 1.3 | 92.5 | 90.4 |
| CNS Pain | 15.5 | 21.4 | 1.5 | 1.5 | 83.6 | 79.4 |
| Respiratory system | 8.1 | 8.4 | 1.8 | 1.9 | 99.1 | 99.3 |
| Infection | 2.9 | 2.7 | 1.6 | 1.1 | 94.7 | 96.7 |
| Endocrine system | 3.4 | 9.3 | 1.2 | 1.2 | 99.6 | 98.5 |
| Contraception | 0.0 | 7.5 | 0.0 | 1.0 | NA | 97.3 |
| Chemotherapy / Immunosuppressant | 0.2 | 0.3 | 1.3 | 1.2 | 100 | 100 |
| Musculoskeletal system | 4.5 | 9.8 | 1.2 | 1.3 | 63.1 | 74.6 |
| Eye | 1.8 | 2.5 | 1.3 | 1.3 | 96.5 | 91.6 |
| Allergy | 4.2 | 4.6 | 1.2 | 1.1 | 78.3 | 79.4 |
| Weight Loss | 0.4 | 0.5 | 1.0 | 1.0 | 71.4 | 83.6 |
| Smoking Cessation | 0.1 | 0.1 | 1.1 | 1.0 | 100 | 91.9 |
| Dietary Supplements | 9.3 | 17.3 | 1.5 | 1.5 | 27.7 | 25.5 |
| Skin | 3.1 | 4.1 | 1.5 | 1.4 | 92.2 | 85.1 |
| Diabetes | 4.1 | 2.6 | 1.5 | 1.4 | 99.3 | 99.8 |
| Genito-urinary system | 3.3 | 1.4 | 1.1 | 1.0 | 94.4 | 99.0 |
| Gout | 1.6 | 0.3 | 1.2 | 1.2 | 96.8 | 98.6 |
| Other | 2.6 | 3.5 | 1.1 | 1.1 | 72.5 | 47.1 |
| Any Category | 49.3 | 62.2 | 3.7 | 3.6 | 88.1 | 82.5 |
| + Individuals not taking each medicine excludedN.B.: Estimates weighted by age, gender, deprivation |  |  |  |  |  |

Table 2 presents the results from the regression models exploring the association of our variables to the number of prescribed and over-the-counter medicines taken. Age was positively associated with both greater prescribed and over-the-counter medicine usage. Females were more likely to take both prescribed and over-the-counter medicines. Although individuals from ethnic minority groups were less likely to use prescribed medicine than White individuals, there were no differences for over-the-counter medicine. BMI was positive associated with the number of prescribed medicines but unrelated to over-the-counter medicine.

**Table 2:** Results from negative binomial regression models analysing the associated factors of medicine usage, split by medicine type (n=18,272).

|  |  |  |
| --- | --- | --- |
| **Variable** | **Total prescribed** | **Total over-the-counter** |
| **IRR** | **95% CI** | **IRR** | **95% CI** |
| **Demographic:** |  |  |  |  |  |  |
| Age | 1.025 | \*\*\* | (1.024-1.027) | 1.027 | \*\*\* | (1.024-1.030) |
| Male | 0.894 | \*\*\* | (0.863-0.925) | 0.600 | \*\*\* | (0.553-0.651) |
| Non-White | 0.756 | \*\*\* | (0.670-0.853) | 0.805 |  | (0.628-1.033) |
| **Social:** |  |  |  |  |  |  |
| *Education:* |  |  |  |  |  |  |
|  None | Reference |  | Reference |  |
|  Secondary | 0.943 | \*\* | (0.904-0.985) | 1.665 | \*\*\* | (1.495-1.856) |
|  Post-Secondary | 1.013 |  | (0.951-1.080) | 1.817 | \*\*\* | (1.573-2.099) |
|  Degree or higher | 0.950 | \* | (0.906-0.997) | 1.967 | \*\*\* | (1.754-2.206) |
| **Health-related:** |  |  |  |  |  |  |
| Body Mass Index | 1.011 | \*\*\* | (1.007-1.014) | 1.001 |  | (0.993-1.009) |
| Units of Alcohol | 0.995 | \*\*\* | (0.993-0.996) | 1.000 |  | (0.996-1.004) |
| Smoker | 1.065 | \* | (1.013-1.120) | 0.786 | \*\*\* | (0.695-0.888) |
| *Walking (per week):* |  |  |  |  |  |  |
|  None | Reference |  | Reference |  |
|  <1 Hour | 1.001 |  | (0.933-1.074) | 1.165 |  | (0.957-1.418) |
|  1-3 Hours | 0.976 |  | (0.914-1.042) | 1.355 | \*\* | (1.131-1.624) |
|  3+ Hours | 0.938 |  | (0.879-1.001) | 1.500 | \*\*\* | (1.253-1.795) |
| *Physical Exercise (per week):* |  |  |  |  |  |  |
|  None | Reference |  | Reference |  |
|  <1 Hour | 0.947 |  | (0.891-1.006) | 1.156 | \* | (1.011-1.323) |
|  1-3 Hours | 0.926 | \*\* | (0.884-0.971) | 1.188 | \*\* | (1.074-1.313) |
|  3+ Hours | 0.854 | \*\*\* | (0.811-0.898) | 1.231 | \*\*\* | (1.106-1.370) |
| **Chronic Health:** |  |  |  |  |  |  |
| Fatigue | 1.208 | \*\*\* | (1.154-1.265) | 1.052 |  | (0.933-1.185) |
| Pain | 1.528 | \*\*\* | (1.467-1.593) | 1.563 | \*\*\* | (1.412-1.730) |
| Insomnia | 1.007 |  | (0.947-1.070) | 1.116 |  | (0.957-1.302) |
| Anxiety | 1.155 | \*\*\* | (1.093-1.221) | 1.064 |  | (0.925-1.224) |
| Depression | 1.449 | \*\*\* | (1.365-1.537) | 1.141 |  | (0.978-1.331) |
| Diabetes | 1.807 | \*\*\* | (1.708-1.912) | 0.747 | \*\* | (0.628-0.888) |
| Breathing Problems | 1.949 | \*\*\* | (1.861-2.041) | 0.972 |  | (0.858-1.101) |
| High Blood Pressure | 1.907 | \*\*\* | (1.835-1.983) | 0.863 | \*\* | (0.776-0.959) |
| Heart Disease | 1.824 | \*\*\* | (1.723-1.931) | 0.771 | \*\* | (0.647-0.920) |
| Osteoarthritis | 1.143 | \*\*\* | (1.086-1.203) | 1.280 | \*\*\* | (1.127-1.453) |
| Stroke | 1.259 | \*\*\* | (1.146-1.384) | 0.600 | \*\* | (0.438-0.824) |
| Cancer | 1.276 | \*\*\* | (1.174-1.387) | 0.850 |  | (0.676-1.069) |
| Constant | 0.220 | \*\*\* | (0.188-0.257) | 0.054 | \*\*\* | (0.037-0.078) |
| /lnalpha | -0.761 |  |  | 1.178 |  |  |
| alpha | 0.467 |  |  | 3.249 |  |  |
| Pseudo r-squared | 0.154 |   |   | 0.039 |   |   |
| NB 1: GP Surgery was also adjusted for, including each surgery in the model as binary variables but not included in the table |
| NB 2: Significance Levels: \* = <0.05, \*\* = <0.01, \*\*\* = <0.001NB 3: IRR = Incidence Rate Ratio, CI = Confidence Interval |

The chronic illness and health conditions variables were consistently positively associated with greater prescribed medicines taken, with only insomnia having no significant relationship. Diabetes, breathing problems, high blood pressure and heart disease had stronger associations than compared to anxiety, stroke or fatigue. Negative associations were found for the relationships between over-the-counter medicine use and diabetes, high blood pressure, stroke and heart disease. Pain and osteoarthritis were significantly and positively associated with both prescribed and over-the-counter medicine use.

Consumption of alcohol was negatively associated with number of prescribed medicines taken, but smoking was associated with increased number of prescribed medicines. For over-the-counter medicine, there was no significant association for alcohol whereas the relationship for smoking was reversed. Walking was not associated with prescribed medicine, but positively associated to over-the-counter medicine. Physical exercise followed a similar pattern to walking for over-the-counter medicines, but the relationship reversed for prescribed medicine. Higher education levels were each negatively associated with total prescribed medicine (in comparison to the ‘no qualification’ category), although the strength of each association was weak. This contrasted with over-the-counter medicine, where education was positively associated with use of over-the-counter medicines.

Tables 3 and 4 present the results of the negative binomial regression for prescribed and over-the-counter medicines, respectively. There were fewer significant associations, however the results mostly followed the findings from Table 2 particularly for age, gender and education. We observed some large effect sizes for some chronic health conditions to prescribed medicines associated with treating the condition (e.g. cardiovascular system medicine and individuals reporting high blood pressure (IRR = 4.205, 95% CIs = 3.995-4.425). These associations were not always immediately obvious, with depression strongly associated with CNS medicine (IRR = 4.210, 95% CIs = 3.770-4.700) and fatigue associated with dietary supplements (IRR = 2.273, 95% CIs = 1.877-2.752). Similar associations were not observed for chronic health conditions and over-the-counter medicines, although chronic pain was significantly positively associated with each medicine type apart from cardiovascular medicine. Some chronic health conditions were also negatively associated with medicine usage (e.g. diabetes and gastro-intestinal system medicine; IRR = 0.327, 95% CIs = 0.142-0.752).

**Table 3:** Results of negative binomial regressions analysing prescribed medicine usage (n=18,272).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Cardiovascular system** | **Gastro-intestinal system** | **CNS** | **CNS Pain** | **Musculoskeletal system** | **Dietary Supplements** |
| **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** |
| **Demographic:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Age | 1.054 | \*\*\* | (1.052-1.056) | 1.031 | \*\*\* | (1.028-1.035) | 1.013 | \*\*\* | (1.009-1.016) | 1.017 | \*\*\* | (1.014-1.020) | 1.056 | \*\*\* | (1.049-1.062) | 1.024 | \*\*\* | (1.018-1.030) |
| Male | 1.298 | \*\*\* | (1.233-1.365) | 0.897 | \*\* | (0.830-0.970) | 0.694 | \*\*\* | (0.632-0.763) | 0.872 | \*\*\* | (0.812-0.936) | 0.440 | \*\*\* | (0.381-0.509) | 0.704 | \*\*\* | (0.599-0.827) |
| Non-White | 0.723 | \*\* | (0.583-0.895) | 0.523 | \*\*\* | (0.369-0.742) | 0.770 |  | (0.570-1.041) | 0.713 | \* | (0.546-0.931) | 0.768 |  | (0.445-1.325) | 0.869 |  | (0.507-1.489) |
| **Social:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Education:* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  |  |  |  |  |  |  |
|  Secondary | 0.955 |  | (0.899-1.015) | 0.974 |  | (0.886-1.070) | 0.959 |  | (0.856-1.075) | 1.099 | \* | (1.009-1.196) | 0.915 |  | (0.775-1.080) | 0.954 |  | (0.786-1.159) |
|  Post-Secondary | 0.936 |  | (0.846-1.036) | 0.987 |  | (0.851-1.145) | 0.943 |  | (0.798-1.115) | 1.173 | \* | (1.032-1.333) | 0.927 |  | (0.711-1.209) | 1.084 |  | (0.814-1.443) |
|  Degree or higher | 0.856 | \*\*\* | (0.800-0.917) | 0.966 |   | (0.867-1.077) | 0.893 |   | (0.782-1.020) | 0.985 |   | (0.888-1.093) | 1.008 |   | (0.837-1.213) | 0.847 |   | (0.677-1.061) |
| **Health-related:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Body Mass Index | 1.032 | \*\*\* | (1.027-1.037) | 1.012 | \*\* | (1.005-1.019) | 1.004 |  | (0.996-1.012) | 1.019 | \*\*\* | (1.013-1.025) | 0.962 | \*\*\* | (0.949-0.975) | 0.980 | \*\* | (0.965-0.994) |
| Units of Alcohol | 0.999 |  | (0.997-1.002) | 0.998 |  | (0.994-1.002) | 0.987 | \*\*\* | (0.982-0.991) | 0.991 | \*\*\* | (0.988-0.995) | 0.982 | \*\*\* | (0.973-0.990) | 0.985 | \*\* | (0.977-0.994) |
| Smoker | 1.167 | \*\*\* | (1.079-1.261) | 0.934 |  | (0.832-1.049) | 1.200 | \*\* | (1.066-1.350) | 1.303 | \*\*\* | (1.187-1.430) | 1.113 |  | (0.907-1.365) | 1.320 | \* | (1.067-1.633) |
| *Walking (per week):* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  |
|  <1 Hour | 1.153 | \*\* | (1.045-1.273) | 0.972 |  | (0.849-1.114) | 0.734 | \*\*\* | (0.629-0.856) | 0.897 |  | (0.799-1.008) | 1.049 |  | (0.814-1.352) | 0.821 |  | (0.616-1.093) |
|  1-3 Hours | 1.176 | \*\* | (1.072-1.289) | 0.931 |  | (0.820-1.058) | 0.639 | \*\*\* | (0.552-0.738) | 0.777 | \*\*\* | (0.696-0.868) | 0.871 |  | (0.686-1.106) | 0.761 | \* | (0.583-0.994) |
|  3+ Hours | 1.162 | \*\* | (1.059-1.274) | 0.867 | \* | (0.762-0.987) | 0.556 | \*\*\* | (0.480-0.644) | 0.756 | \*\*\* | (0.676-0.845) | 0.836 |  | (0.658-1.062) | 0.671 | \*\* | (0.513-0.877) |
| *Physical Exercise (per week):* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  |
|  <1 Hour | 0.955 |  | (0.869-1.050) | 0.884 |  | (0.765-1.022) | 0.834 | \* | (0.707-0.983) | 0.972 |  | (0.857-1.102) | 0.935 |  | (0.730-1.197) | 1.000 |  | (0.761-1.315) |
|  1-3 Hours | 0.919 |  | (0.854-0.989) | 0.880 | \* | (0.787-0.985) | 0.764 | \*\*\* | (0.669-0.872) | 0.859 | \*\* | (0.774-0.953) | 1.032 |  | (0.860-1.237) | 0.892 |  | (0.715-1.113) |
|  3+ Hours | 0.927 |  | (0.858-1.002) | 0.787 | \*\*\* | (0.692-0.896) | 0.633 | \*\*\* | (0.538-0.744) | 0.720 | \*\*\* | (0.634-0.817) | 0.873 |  | (0.703-1.083) | 0.881 |  | (0.686-1.130) |
| **Chronic Health:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Fatigue | 1.017 |  | (0.953-1.085) | 1.503 | \*\*\* | (1.369-1.649) | 1.213 | \*\* | (1.084-1.357) | 1.099 | \* | (1.012-1.193) | 1.646 | \*\*\* | (1.393-1.943) | 2.273 | \*\*\* | (1.877-2.752) |
| Pain | 1.047 |  | (0.986-1.112) | 1.833 | \*\*\* | (1.678-2.003) | 1.534 | \*\*\* | (1.378-1.708) | 5.088 | \*\*\* | (4.695-5.514) | 1.952 | \*\*\* | (1.671-2.280) | 1.232 | \* | (1.021-1.487) |
| Insomnia | 0.954 |  | (0.873-1.042) | 1.017 |  | (0.907-1.141) | 0.926 |  | (0.812-1.056) | 1.060 |  | (0.961-1.170) | 1.069 |  | (0.868-1.317) | 0.949 |  | (0.739-1.220) |
| Anxiety | 1.109 | \* | (1.021-1.204) | 1.178 | \*\* | (1.056-1.314) | 2.138 | \*\*\* | (1.912-2.390) | 0.936 |  | (0.850-1.032) | 0.867 |  | (0.704-1.066) | 1.169 |  | (0.925-1.478) |
| Depression | 1.048 |  | (0.957-1.147) | 1.215 | \*\* | (1.081-1.366) | 4.210 | \*\*\* | (3.770-4.700) | 1.312 | \*\*\* | (1.186-1.451) | 1.170 |  | (0.933-1.467) | 1.237 |  | (0.964-1.587) |
| Diabetes | 1.675 | \*\*\* | (1.563-1.795) | 0.895 |  | (0.791-1.013) | 0.965 |  | (0.823-1.132) | 0.878 | \* | (0.783-0.985) | 0.955 |  | (0.754-1.208) | 1.613 | \*\*\* | (1.258-2.068) |
| Breathing Problems | 0.983 |  | (0.917-1.054) | 1.237 | \*\*\* | (1.123-1.362) | 0.929 |  | (0.821-1.052) | 1.029 |  | (0.941-1.124) | 1.314 | \*\* | (1.103-1.566) | 1.186 |  | (0.962-1.461) |
| High Blood Pressure | 4.205 | \*\*\* | (3.995-4.425) | 1.076 |  | (0.989-1.172) | 0.970 |  | (0.868-1.085) | 1.013 |  | (0.937-1.096) | 0.876 |  | (0.750-1.022) | 1.154 |  | (0.962-1.384) |
| Heart Disease | 3.330 | \*\*\* | (3.115-3.560) | 1.377 | \*\*\* | (1.236-1.535) | 1.099 |  | (0.940-1.284) | 1.087 |  | (0.977-1.210) | 1.105 |  | (0.893-1.367 | 1.232 |  | (0.957-1.588) |
| Osteoarthritis | 0.973 |  | (0.909-1.042) | 1.216 | \*\*\* | (1.105-1.339) | 0.978 |  | (0.858-1.114) | 1.720 | \*\*\* | (1.587-1.866) | 1.653 | \*\*\* | (1.402-1.949) | 1.099 |  | (0.883-1.368) |
| Stroke | 1.631 | \*\*\* | (1.463-1.818) | 1.097 |  | (0.921-1.308) | 1.238 |  | (0.994-1.543) | 1.002 |  | (0.846-1.186) | 1.012 |  | (0.722-1.418) | 0.912 |  | (0.603-1.380) |
| Cancer | 0.964 |  | (0.862-1.078) | 1.386 | \*\*\* | (1.194-1.609) | 0.959 |  | (0.766-1.120) | 1.127 |  | (0.969-1.311) | 1.290 |  | (0.977-1.702) | 1.325 |  | (0.943-1.860) |
| Constant | 0.005 | \*\*\* | (0.003-0.006) | 0.018 | \*\*\* | (0.013-0.026) | 0.085 | \*\*\* | (0.058-0.125) | 0.033 | \*\*\* | (0.024-0.044) | 0.010 | \*\*\* | (0.005-0.018) | 0.028 | \*\*\* | (0.014-0.055) |
| /lnalpha | -0.906 |  |  | -1.327 |  |  | -0.628 |  |  | -1.175 |  |  | 0.909 |  |  | 1.344 |  |  |
| alpha | 0.404 |  |  | 0.265 |  |  | 0.534 |  |  | 0.309 |  |  | 2.481 |  |  | 3.836 |  |  |
| Pseudo r-squared | 0.284 |   |  | 0.142 |   |  | 0.176 |   |  | 0.208 |   |  | 0.144 |   |  | 0.082 |   |  |
| NB 1: GP Surgery was also adjusted for, including each surgery in the model as binary variables but not included in the table |
| NB 2: Significance Levels: \* = <0.05, \*\* = <0.01, \*\*\* = <0.001NB 3: IRR = Incidence Rate Ratio, CI = Confidence IntervalNB 4: CNS = Central Nervous System |

**Table 4:** Results of negative binomial regressions analysing over-the-counter medicine usage (n=18,272).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Cardiovascular system** | **Gastro-intestinal system** | **CNS** | **CNS Pain** | **Musculoskeletal system** | **Dietary Supplements** |
| **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** |
| **Demographic:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Age | 1.052 | \*\*\* | (1.042-1.063) | 1.033 | \*\*\* | (1.023-1.044) | 0.995 |  | (0.985-1.004) | 1.009 | \*\* | (1.003-1.015) | 1.057 | \*\*\* | (1.050-1.064) | 1.031 | \*\*\* | (1.027-1.034) |
| Male | 0.963 |  | (0.765-1.212) | 0.505 | \*\*\* | (0.377-0.675) | 0.493 | \*\*\* | (0.366-0.664) | 0.597 | \*\*\* | (0.509-0.701) | 0.624 | \*\*\* | (0.530-0.736) | 0.573 | \*\*\* | (0.519-0.633) |
| Non-White | 0.769 |  | (0.304-1.947) | 1.305 |  | (0.591-2.877) | 1.147 |  | (0.569-2.314) | 0.720 |  | (0.433-1.196) | 0.953 |  | (0.501-1.814) | 0.746 |  | (0.542-1.027) |
| **Social:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Education*: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  |
|  Secondary | 1.465 | \*\* | (1.101-1.949) | 3.162 | \*\*\* | (2.155-4.639) | 1.665 | \* | (1.126-2.463) | 1.883 | \*\*\* | (1.523-2.328) | 1.700 | \*\*\* | (1.380-2.094) | 1.659 | \*\*\* | (1.454-1.892) |
|  Post-Secondary | 1.342 |  | (0.859-2.095) | 3.457 | \*\*\* | (2.113-5.656) | 2.346 | \*\*\* | (1.476-3.730) | 2.032 | \*\*\* | (1.542-2.676) | 1.486 | \* | (1.082-2.041) | 1.806 | \*\*\* | (1.514-2.155) |
|  Degree or higher | 1.539 | \*\* | (1.130-2.096) | 2.862 | \*\*\* | (1.878-4.361) | 1.916 | \*\* | (1.253-2.928) | 1.943 | \*\*\* | (1.541-2.450) | 2.051 | \*\*\* | (1.651-2.549) | 2.045 | \*\*\* | (1.781-2.348) |
| **Health-related:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Body Mass Index | 1.036 | \*\* | (1.013-1.059) | 0.989 |  | (0.963-1.015) | 1.034 | \*\* | (1.011-1.058) | 1.021 | \*\* | (1.006-1.035) | 1.004 |  | (0.987-1.021) | 0.986 | \*\* | (0.976-0.996) |
| Units of Alcohol | 1.003 |  | (0.992-1.013) | 1.004 |  | (0.991-1.018) | 1.000 |  | (0.987-1.014) | 1.000 |  | (0.992-1.008) | 1.007 |  | (0.999-1.014) | 0.998 |  | (0.993-1.003) |
| Smoker | 1.412 | \* | (1.016-1.961) | 0.603 | \* | (0.379-0.962) | 1.375 |  | (0.987-1.915) | 0.897 |  | (0.717-1.122) | 0.669 | \* | (0.490-0.913) | 0.690 | \*\*\* | (0.590-0.808) |
| *Walking (per week):* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  |
|  <1 Hour | 2.193 | \* | (1.141-4.214) | 0.721 |  | (0.379-1.372) | 0.546 |  | (0.267-1.115) | 1.268 |  | (0.885-1.816) | 0.997 |  | (0.647-1.536) | 1.174 |  | (0.916-1.505) |
|  1-3 Hours | 2.291 | \*\* | (1.228-4.275) | 1.250 |  | (0.718-2.177) | 1.305 |  | (0.728-2.337) | 1.375 |  | (0.985-1.920) | 1.218 |  | (0.823-1.801) | 1.403 | \*\* | (1.116-1.764) |
|  3+ Hours | 3.106 | \*\*\* | (1.676-5.758) | 1.004 |  | (0.574-1.756) | 1.631 |  | (0.918-2.896) | 1.422 | \* | (1.021-1.982) | 1.622 | \* | (1.104-2.384) | 1.519 | \*\*\* | (1.211-1.907) |
| *Physical Exercise (per week):* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  None | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  | Reference |  |
|  <1 Hour | 1.308 |  | (0.899-1.903) | 1.045 |  | (0.658-1.660) | 0.962 |  | (0.620-1.490) | 0.963 |  | (0.742-1.251) | 1.259 |  | (0.950-1.669) | 1.158 |  | (0.983-1.363) |
|  1-3 Hours | 0.906 |  | (0.660-1.244) | 1.231 |  | (0.894-1.694) | 0.910 |  | (0.652-1.271) | 0.971 |  | (0.800-1.180) | 1.511 | \*\*\* | (1.248-1.829) | 1.227 | \*\* | (1.089-1.383) |
|  3+ Hours | 1.029 |  | (0.746-1.421) | 1.190 |  | (0.831-1.702) | 0.760 |  | (0.509-1.136) | 0.939 |  | (0.757-1.163) | 1.645 | \*\*\* | (1.351-2.003) | 1.334 | \*\*\* | (1.175-1.514) |
| **Chronic Health:** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Fatigue | 1.027 |  | (0.741-1.425) | 1.033 |  | (0.720-1.483) | 0.860 |  | (0.592-1.249) | 1.076 |  | (0.872-1.327) | 0.806 |  | (0.627-1.035) | 1.086 |  | (0.940-1.254) |
| Pain | 1.192 |  | (0.896-1.585) | 1.938 | \*\*\* | (1.424-2.639) | 2.765 | \*\*\* | (2.027-3.772) | 3.457 | \*\*\* | (2.908-4.111) | 1.449 | \*\*\* | (1.192-1.763) | 1.140 | \* | (1.005-1.293) |
| Insomnia | 1.084 |  | (0.715-1.645) | 0.989 |  | (0.642-1.522) | 1.554 | \* | (1.031-2.342) | 1.084 |  | (0.834-1.408) | 1.135 |  | (0.843-1.528) | 1.091 |  | (0.907-1.311) |
| Anxiety | 1.114 |  | (0.756-1.640) | 1.505 | \* | (1.031-2.197) | 1.228 |  | (0.830-1.816) | 1.009 |  | (0.792-1.286) | 0.701 | \* | (0.509-0.963) | 1.079 |  | (0.911-1.277) |
| Depression | 0.940 |  | (0.601-1.471) | 1.364 |  | (0.888-2.094) | 1.360 |  | (0.902-2.052) | 1.131 |  | (0.871-1.469) | 0.880 |  | (0.612-1.266) | 1.201 |  | (0.996-1.447) |
| Diabetes | 0.840 |  | (0.559-1.263) | 0.327 | \*\* | (0.142-0.752) | 0.456 | \* | (0.210-0.994) | 0.857 |  | (0.616-1.194) | 0.597 | \* | (0.403-0.883) | 0.770 | \* | (0.623-0.952) |
| Breathing Problems | 0.615 | \* | (0.412-0.917) | 1.121 |  | (0.764-1.646) | 0.772 |  | (0.496-1.200) | 0.991 |  | (0.786-1.249) | 0.925 |  | (0.714-1.197) | 1.042 |  | (0.897-1.210) |
| High Blood Pressure | 1.189 |  | (0.922-1.533) | 0.952 |  | (0.684-1.326) | 0.808 |  | (0.548-1.192) | 0.653 | \*\*\* | (0.527-0.810) | 0.682 | \*\*\* | (0.557-0.834) | 0.976 |  | (0.861-1.106) |
| Heart Disease | 1.103 |  | (0.751-1.618) | 0.855 |  | (0.491-1.491) | 0.850 |  | (0.423-1.709) | 0.489 | \*\*\* | (0.329-0.725) | 0.599 | \*\* | (0.416-0.863) | 0.861 |  | (0.698-1.061) |
| Osteoarthritis | 1.015 |  | (0.729-1.412) | 1.646 | \*\* | (1.165-2.324) | 1.359 |  | (0.909-2.031) | 1.359 | \*\* | (1.088-1.700) | 1.720 | \*\*\* | (1.403-2.107) | 1.268 | \*\* | (1.089-1.477) |
| Stroke | 1.225 |  | (0.664-2.262) | 0.545 |  | (0.170-1.749) | 0.490 |  | (0.119-2.025) | 0.842 |  | (0.471-1.504) | 0.337 | \* | (0.138-0.822) | 0.560 | \*\* | (0.374-0.840) |
| Cancer | 0.624 |  | (0.322-1.209) | 0.421 |  | (0.155-1.148) | 1.514 |  | (0.766-2.990) | 0.903 |  | (0.584-1.396) | 1.134 |  | (0.777-1.655) | 0.840 |  | (0.637-1.107) |
| Constant | 0.000 | \*\*\* | (0.000-0.000) | 0.001 | \*\*\* | (0.000-0.004) | 0.004 | \*\*\* | (0.001-0.012) | 0.011 | \*\*\* | (0.006-0.023) | 0.001 | \*\*\* | (0.000-0.002) | 0.033 | \*\*\* | (0.021-0.052) |
| /lnalpha | 0.954 |  |  | -0.118 |  |  | -35.436 |  |  | 1.382 |  |  | -1.068 |  |  | 1.164 |  |  |
| alpha | 2.595 |  |  | 0.889 |  |  | 0.000 |  |  | 3.981 |  |  | 0.344 |  |  | 3.202 |  |  |
| Pseudo r-squared | 0.072 |   |   | 0.087 |   |   | 0.0829 |   |   | 0.062 |   |   | 0.110 |   |   | 0.047 |   |   |
| NB 1: GP Surgery was also adjusted for, including each surgery in the model as binary variables but not included in the table |
| NB 2: Significance Levels: \* = <0.05, \*\* = <0.01, \*\*\* = <0.001NB 3: IRR = Incidence Rate Ratio, CI = Confidence IntervalNB 4: CNS = Central Nervous System |

**Discussion**

This study has demonstrated variations by demographic, social and health factors in prescribed and over-the-counter medicine usage within a large cohort. Prescribed medicine usage was associated with the presence of chronic health conditions and poor health-related behaviours. Taking over-the-counter medicine was associated with higher levels of education, and positive health behaviours. Gender was also important for the purchasing of both medicine type, although the effect size was larger for over-the-counter medicines. The patterns were fairly consistent when analysing by medicine type.

The main strength of the study is it addresses the dearth of evidence of social and demographic patterns in medicine usage at the population level particularly for over-the-counter medicines. There are several limitations to our study. The analysis is cross-sectional and therefore cannot demonstrate causality. Future waves of the Yorkshire Health Study will allow the findings to be tested longitudinally, helping to strengthen conclusions and recommendations (26). Data collected in the Yorkshire Health Study were self-reported and this may lead to bias in estimates. For example, recall bias may lead to under-reporting of medications particularly for over-the-counter medications which are taken sporadically or not always thought of as medicines (e.g. vitamins). Medicine dosage was not measured in the data limiting our comparison of medicines. The categories used to group together medicines may also hide variations in patterns, particularly where medications may be used for different purposes despite operating at the same organ system/area of the body. Finally, we only use one measure of socio-economic status (education) and extending our analyses to additional measures such as income or occupation will help to improve our understanding socio-economic behaviours in medicine usage.

While individuals of high education took fewer medications compared to individuals with no qualifications (Table 2), the effect size was only small and medicine usage was influenced more strongly by health status and age. In contrast, a distinct social gradient in over-the-counter medicine usage was observed. These findings support similar results found in other countries (11,21). Individuals of high education are associated with better employment prospects and higher incomes, and hence they will be in a better position to absorb the financial burden associated with purchasing additional medicines particularly if it allows them to avoid long waiting times to see their GP (9,11,21). Education also incorporates an individual’s ability to cognitively understand the potential benefits of over-the-counter medicines, as well as effectively communicate health information to clinicians (38). Alternative explanations for the role of education may include: differences in compliance to treatment, inequalities in access to pharmacies, and variations in self-treatment behaviours (10,11). Evaluating the contribution of these potential pathways is important for future research to be able to address social inequalities in health behaviours.

The relationships for physical exercise, walking and smoking may also be explained similarly to that of the cognitive role of education. Individuals who exercise regularly or do not smoke have been shown to have greater health consciousness (39,40). Health consciousness may be captured through these variables in our analysis and it may be that these types of individuals also try to maximise their health using over-the-counter medicines. Given the association between high education and positive health-related behaviours throughout the literature (19), the role played by cognition appears important. This is contrary to the relationships with prescribed medicine where physical exercise is protective to health (35–37) and smoking damaging (31,33,34), independently influencing the need for prescribed medicine. However, the results for alcohol consumption only followed this pattern for prescribed medicine.

Individuals who were non-White were found to be less likely to take prescribed medicines (but not over-the-counter medicines). Our results support evidence from the US which has found similar associations of lower medicine usage amongst non-White individuals (14,41). However, there is little understanding of why this this association exists and therefore further research should explore possible explanations including social factors, access to health care or cultural factors. Addressing inequalities in health care usage by ethnicity will be important given that most medicines are only available through prescriptions in the UK.

In summary, we find differences in prescribed and over-the-counter medicine usage by demographic, social and health characteristics. Education was an important factor in explaining variations in over-the-counter utilisation. With the NHS moving towards greater self-medication (both to empower patients and reduce costs), such an approach may have important implications for social inequalities in health and health-related behaviours.

**Acknowledgements** This publication presents independent research as part of the Obesity Theme in CLAHRC SY 2008-2013 which is supported by the National Institute for Health Research, Collaboration for Leadership in Applied Health Research and Care, Yorkshire and Humber (NIHR CLAHRC YH) and the University of Sheffield. The views and opinions expressed are those of the authors, and not necessarily those of the NHS, the NIHR or the Department of Health. Ethical approval was not required since the study was a secondary data analysis.

**Funding Statement** Emma Little was funded by a Wellcome Trust summer internship which was linked to this study. This research received no other specific grant from any funding agency in the public, commercial or not-for-profit sectors.

**Competing Interests** No conflicts of interest are declared.

**Data Sharing Statement** Data from the YHS can be applied for access through [www.yorkshirehealthstudy.org](http://www.yorkshirehealthstudy.org). MG is happy to share the statistical code for the analyses and should be contacted using mark.green@liverpool.ac.uk.

**Contributorship Statement** MG, MS and CR designed the study. MG, EL and RC prepared the data. MG and EL conducted the analysis. All authors were involved in the writing of the manuscript.

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