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Socioeconomic and health factors related to polypharmacy and medication management: analysis of a Household Health Survey in North West Coast England

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ABSTRACT

Objectives To examine the socioeconomic and demographic drivers associated with polypharmacy (5–9 medicines), extreme polypharmacy (9–20 medicines) and increased medication count.

Design, setting and participants A total of 5509 participants, from two waves of the English North West Coast, Household Health Survey were analysed

Outcome measures Logistic regression modelling was used to find associations with polypharmacy and extreme polypharmacy. A negative binomial regression identified associations with increased medication count. Descriptive statistics explored associations with medication management.

Results Age and number of health conditions account for the greatest odds of polypharmacy. ORs (95% CI) were greatest for those aged 65+ (3.87, 2.45 to 6.13) and for those with ≥5 health conditions (10.87, 5.94 to 19.88). Smaller odds were seen, for example, in those prescribed cardiovascular medications (3.08, 2.36 to 4.03), or reporting >3 emergency attendances (1.97, 1.23 to 3.17). Extreme polypharmacy was associated with living in a deprived neighbourhood (1.54, 1.06 to 2.26). The greatest risk of increased medication count was associated with age, number of health conditions and use of primary care services. Relative risks (95% CI) were greatest for those aged 65+ (2.51, 2.23 to 2.82), those with ≥5 conditions (10.26, 8.86 to 11.88) or those reporting >18 primary care visits (2.53, 2.18 to 2.93). Smaller risks were seen in, for example, respondents with higher levels of income deprivation (1.35, 1.03 to 1.77). Polypharmic respondents were more likely to report medication management difficulties associated with taking more than one medicine at a time ($p<0.001$). Furthermore, individuals reporting a mental health condition, were significantly more likely to consistently report difficulties managing their medication ($p<0.001$).

Conclusion Age and number of health conditions are most associated with polypharmacy. Thus, delaying or preventing the onset of long-term conditions may help to reduce polypharmacy. Interventions to reduce income inequalities and health inequalities generally could support a reduction in polypharmacy, however, more research is needed in this area. Furthermore, increased prevention and support, particularly with medication management, for those with mental health conditions may reduce adverse medication effects.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first time that polypharmacy has been explored in the context of physical and mental health, alongside socioeconomic factors in an adult household population in the North West Coast of England.
⇒ Data from the Household Health Survey were self-reported and as such are subject to the recall biases and inaccuracies of the respondents. Categorisation in the logistic regression will have minimised bias.
⇒ We classified 'depressed' using a relatively severe level and found that those with mental health issues were more likely to report medication management difficulties along with those with extreme polypharmacy.

INTRODUCTION

Polypharmacy, commonly defined as the prescription of five or more medicines,[1] is increasing, particularly among older, multimorbid populations. With life expectancy higher than at any previous time, those over 65 years represent one of the fastest growing age groups in the UK.[2 3] Healthy life expectancy has increased, however, the number of years lived in poor health after the age of 65 is also growing. In Northern England people can expect to live fewer years in good health compared with other regions[4] and although women are living longer than men, they will live almost four additional years in poor health.[4] Those living longer are likely to develop more than one long-term physical or mental health condition.[5] Furthermore, mental health conditions, such as depression, are associated with multimorbidity in older populations.[6] Long-term health conditions can often be well managed with medication, however with increased number of conditions or the compounding effect of both mental and physical health conditions, levels of polypharmacy increase.[6 7] A potential consequence of which, can be an increase in adverse drug reactions, drug–drug interactions, difficulties with medication adherence, and increased healthcare costs.[8] Medication guidelines for long-term conditions promote polypharmacy, however, there is a drive towards medicines optimisation and deprescribing where possible, while continuing to manage complex conditions effectively.[9 10]

In addition to ageing and multimorbidity, socioeconomic and demographic determinants are associated with polypharmacy. Studies have found an association between polypharmacy and lower wealth[1 11] as well as polypharmacy and lower education.[11 12] Lower education can affect the level of health literacy required to effectively self-manage health conditions and medication, while level of wealth can determine factors such as lifestyle, nutrition and ability to afford the increased healthcare or prescription costs associated with polypharmacy.[8] The relationship between socioeconomic status, including deprivation, has been explored with some limited evidence to support an association.[13 14] Higher levels of non-cardiovascular polypharmacy have been found in females, while males report higher levels of cardiovascular polypharmacy, yet there is limited evidence to support any other gender differences associated with polypharmacy. Polypharmacy has been associated with higher levels of cognitive decline, depression and falls in African American cohorts, however, evidence for a direct correlation between ethnicity and polypharmacy is limited.[11]

Little is known about the relationship between the socioeconomic and demographic mechanisms that may influence level of polypharmacy and how this may relate to health conditions and healthcare utilisation. Even less is known about the influencing factors that increase medication counts to higher levels or even extreme polypharmacy. Understanding additional drivers of polypharmacy may help to inform targeted prevention interventions. This study aims to explore the socioeconomic and demographic drivers associated with polypharmacy, extreme polypharmacy and increased medication count using survey data from the North West coastal area of England.

METHODS

Data

The Household Health Survey waves I and II were used in this study. This survey was codesigned with National Institute for Health Research, Collaboration for Leadership in Applied Health Research and Care, North West Coast's (NIHR CLAHRC NWC) Local Authority, NHS Trust and academic partners and public advisors. Data were collected for wave I (August 2015–January 2016) and wave II (August–December 2018) from identified deprived neighbourhoods and, in wave I only, from less deprived areas across nine Local Authority areas in the North West Coast area. A random locational probability sampling approach was taken. Data were gathered by face-to-face data collection in respondents' homes using hand-held Computer Aided Personal Interviewing devices and showcards to illustrate questions. A total sample of 4319 in the first wave and 3412 in the second wave was collected. The survey aimed to collect repeated samples where consent was gained to recontact from the first wave. This resulted in a repeated sample of 871. Further details of the data collection methods have been reported elsewhere.[15] The questionnaire sought to examine a broad range of research questions relating to the socioeconomic determinants of physical and mental health and the mechanisms through which they have an influence with a focus on inequalities in, for example, healthcare utilisation.

Measures

A measure of polypharmacy was defined from a question that asked respondents how many types of prescribed medicines they had taken in the past week (None/1-4/5-9/10-20). Demographic measures used were: self-reported age group, sex and ethnicity which was recategorised into white and black and minority ethnicities (BME). Socioeconomic measures included neighbourhood category (deprived and less deprived), level of education converted to high (degree or higher), medium (professional or vocational) and low (no qualifications), working (yes/no) and housing (own outright/mortgage/rent). Due to the fact that we used the employment and education variables reported in the survey, we only included the indices of multiple deprivation: income domain to represent finance, alongside a survey variable that measured how respondents were managing financially by asking whether or not they were in debt.

Health measures included smoking (never smoked/ex-smoker/smoker), alcohol consumption (never drink/irregular drinker/regular drinker), self-reported health status using the EuroQual Visual Analogue Scale (1–100, best imaginable-worst imaginable health),[16] and the number of health conditions reported. Depression was measured using the 9-item Patient Health Questionnaire (PHQ-9),[17] respondents were deemed depressed where a score of 10 or more was reported. In addition, information about whether the respondent was taking cardiovascular medication was included, due to the high level of medication prescribed for this condition.[18] Self-reported visits to primary, secondary and emergency care were also included.

Additional data resources available at Lower Super Output Level (LSOA) level, a geographical small area measure consisting on average of 1500 people, were used. They included distance to general practice, walk-in unit and accident and emergency (A&E), estimated using the Routino open source tool (https://www.routino.org/uk/) to calculate the shortest road distance between the

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centre of each postcode and each type of health service. The average distance for all postcodes in an LSOA was estimated and matched to each survey respondent's LSOA.

Patient and public involvement

Public advisors were involved in the development of the Household Health Survey. Public advisors were typically carers or people with extensive patient experience. In addition, public advisors were involved in general writing group discussions and a public advisor (TC) contributed to drafting the manuscript.

Analysis

We employed two generalised linear models to study the relationship between polypharmacy, health and socioeconomic factors:

1. A logistic regression model was used to investigate factors that influence the difference between non-polypharmic use of medications and polypharmacy. For the purposes of this study, we define no polypharmacy as being on 1–4 medications, polypharmacy as 5–9 medicines and extreme polypharmacy as 10 or more medications.
2. A negative binomial regression model was used to investigate factors that are associated with an increase in the number of medications taken. Note that this includes people on zero medications.

The two approaches are complementary, in that the logistic regression allows us to study the transition for 'normal' medication use to polypharmacy, while the negative binomial model studies the factors influencing increase in medication use more generally. Both models have the formulation of a generalised linear model with expected value $E[\mathbf{y}] = \boldsymbol{\mu}$ such that:

$\boldsymbol{\mu} = g^{-1}(X\beta)$ where $\mathbf{y}$ is the response variable, X is the design matrix, and β is the vector of coefficients. For the logistic regression model, the link function g is the logit function so that beta coefficients are on the log-odds scale, while for the negative binomial model it is the log function, so that (exponentiated) coefficients represent the rate ratio, or the multiplier of medication count expected for that predictor over the reference value. The models were fitted using the R programming language, V.4.0.4.[19]

We made the following major analysis choices:

- Primary care, A&E and walk-in visits were coded as ordinal variables determined by the number of visits/appointments.
- Health conditions were coded as an ordinal variable determined by the number of conditions.
- Depression was coded as a binary variable, where a person is classified as depressed if they scored 10 or higher on the PHQ-9 test.
- Individuals on more than 20 medications were excluded from the analysis (a total of 35 cases, representing less than 1% of respondents). Of those who reported being prescribed medication 95% reported less than 13 medicines, with a mean of 3. Thus, the higher counts were extreme outliers and were less reliably recorded.
- For the logistic regression, we chose to focus on polypharmic individuals on 5–9 medications, as the drivers behind extreme polypharmacy (10 or more medications) are likely to be different.

See online supplemental file (appendix I) for a detailed list of analysis choices and their rationale, further diagnostics, as well as a logistic regression analysis that includes extreme polypharmacy (online supplemental file: appendices II and III).

RESULTS

The interpretation of coefficients is necessarily different; for the logistic regression, the coefficients represent ORs. For example, in table 1 the odds of a respondent in the 35–44 age band experiencing polypharmacy is 2.2 times that of a respondent in the 18–34 band. For the negative binomial model, the coefficients represent relative risks. For example, in table 2, an individual in the 35–44 age band has a mean medication count approximately 1.6 times that of an individual in the 18–34 band.

Table 1 shows that age and number of health conditions are most strongly associated with polypharmacy. Self-reported poor health, being prescribed cardiovascular medication, reporting medication side effects, being an ex-smoker and more than three A&E attendances in the previous year are all associated with greater odds of polypharmacy (5–9 medicines). Working, regular alcohol consumption and self-reported debt were significantly associated with lower odds of polypharmacy (5–9 medicines).

Online supplemental appendix II examines the odds of reporting polypharmacy and extreme levels of polypharmacy (5–20 medicines) compared with no polypharmacy (1–4 medicines). Findings indicate that older age and increased number of conditions overwhelmingly account for the greatest odds of increased polypharmacy ($p<0.001$, respectively). Almost all other variables show a pattern consistent with table 1, with the exception of living in a deprived neighbourhood, which increases the odds of polypharmacy or extreme polypharmacy marginally to 1.54 (95% CI 1.06 to 2.26, $p=0.03$) compared with those from less deprived areas and reporting 1–3 primary care appointments in the past year, which decreases the odds of polypharmacy or extreme polypharmacy to 0.57 (95% CI 0.38 to 0.87, $p=0.01$) compared with no appointments.

The negative binomial count model (table 2), indicates the variables most and least associated with an increase in medication count. The most significant variables are age, employment status, self-reported health, health conditions, taking cardiovascular medication, use of primary care services and high use of A&E. The greatest increase in risk is associated with age, number of conditions, and use of primary care services. Smaller risks associated with experiencing an increase in medication count were seen in those with higher income deprivation, depression,

Table 1 Logistic regression model comparing the probability of polypharmacy (5–9 medications) to no polypharmacy (1–4 medications) (n=2614)

Parameter	Parameter level	Coefficient OR	CI (95%)	P value
Intercept		**0.023**	**0.010 to 0.053**	**<0.001**
Wave	2	1.235	0.986 to 1.547	0.066
Neighbourhood type	Reference: less deprived			
	Deprived	1.410	0.948 to 2.097	0.089
Age band	Reference: 18–34			
	35–44	**2.204**	**1.327 to 3.660**	**0.002**
	45–54	**2.621**	**1.627 to 4.223**	**<0.001**
	55–64	**3.968**	**2.489 to 6.327**	**<0.001**
	65+	**3.873**	**2.445 to 6.134**	**<0.001**
Sex	Female	0.947	0.760 to 1.180	0.627
Ethnicity	BME	0.699	0.423 to 1.156	0.163
Working	**Yes**	**0.690**	**0.506 to 0.941**	**0.019**
Income (IMD score)		0.934	0.362 to 2.408	0.887
Debt	**Yes**	**0.659**	**0.493 to 0.880**	**0.005**
Smoking	Reference: never			
	Ex-smoker	**1.292**	**1.004 to 1.662**	**0.046**
	Current smoker	0.855	0.643 to 1.137	0.280
Alcohol	**Reference: never**			
	Irregular	0.843	0.633 to 1.123	0.244
	Regular	**0.656**	**0.507 to 0.848**	**0.001**
Self-reported health	**Poor**	**1.792**	**1.380 to 2.327**	**<0.001**
Side effects	**Yes**	**1.868**	**1.389 to 2.513**	**<0.001**
Depressed	Yes	1.151	0.867 to 1.526	0.331
Health condition	Reference: no conditions			
	One	**1.520**	**0.875 to 2.641**	**0.137**
	Two	**2.499**	**1.434 to 4.353**	**0.001**
	Three or four	**4.050**	**2.337 to 7.017**	**<0.001**
	Five or more	**10.871**	**5.943 to 19.883**	**<0.001**
Cardiovascular	**Takes medication**	**3.082**	**2.359 to 4.025**	**<0.001**
Primary care (no. visits in last year)	**Reference: none**			
	1–3	0.679	0.427 to 1.080	0.102
	4–6	1.138	0.721 to 1.798	0.579
	7–18	1.513	0.955 to 2.398	0.078
	>18	1.292	0.723 to 2.309	0.388
A&E (no. visits in last year)	Reference: none			
	1	1.025	0.756 to 1.390	0.874
	2–3	0.886	0.629 to 1.247	0.487
	>3	**1.973**	**1.229 to 3.166**	**0.005**
Walk-in unit (no. visits in last year)	Reference: none			
	1–2	0.994	0.713 to 1.385	0.970
	>2	1.242	0.705 to 2.189	0.453

Statistically significant associations are highlighted in bold font.
A&E, accident and emergency; IMD, indices of multiple deprivation.

Table 2 Negative binomial count model for number of prescribed medications reported by respondents (n=5509)

Parameter	Parameter level	Coefficient RR	CI (95%)	P value
Intercept		**0.078**	**0.063 to 0.097**	**<0.001**
Wave	2	1.056	0.991 to 1.125	0.093
Neighbourhood type	Reference: Less deprived			
	Deprived	1.040	0.932 to 1.161	0.480
Age band	Reference: 18–34			
	35–44	**1.570**	**1.397 to 1.764**	**<0.001**
	45–54	**2.058**	**1.841 to 2.301**	**<0.001**
	55–64	**2.275**	**2.032 to 2.547**	**<0.001**
	65+	**2.511**	**2.234 to 2.822**	**<0.011**
Sex	Female	1.051	0.990 to 1.115	0.102
Ethnicity	**BME**	**0.812**	**0.711 to 0.927**	**0.002**
Education	Reference: high (degree)			
	Medium	0.989	0.896 to 1.093	0.833
	Low (none)	1.003	0.904 to 1.112	0.960
Working	**Yes**	**0.744**	**0.685 to 0.808**	**<0.001**
Tenure of housing	Reference: own			
	Mortgaged	1.026	0.920 to 1.143	0.647
	Rent or other	1.009	0.935 to 1.089	0.819
Income (IMD score)		**1.352**	**1.032 to 1.772**	**0.028**
Debt	Yes	1.053	0.978 to 1.134	0.173
Managing financially	Reference: doing well			
	Getting by	0.991	0.919 to 1.068	0.807
	Struggling	0.930	0.833 to 1.038	0.195
Smoking	Reference: never			
	Ex-smoker	**1.096**	**1.022 to 1.176**	**0.011**
	Current smoker	1.045	0.969 to 1.126	0.256
Alcohol	Reference: never			
	Irregular	0.946	0.876 to 1.022	0.160
	Regular	**0.900**	**0.840 to 0.965**	**0.003**
Self-reported health	**Poor**	**1.367**	**1.270 to 1.472**	**<0.001**
Depressed	**Yes**	**1.103**	**1.022 to 1.190**	**0.012**
Health condition	Reference: no conditions			
	One	**5.308**	**4.703 to 5.990**	**<0.001**
	Two	**7.327**	**6.439 to 8.337**	**<0.001**
	Three or four	**9.033**	**7.930 to 10.289**	**<0.001**
	Five or more	**10.257**	**8.856 to 11.879**	**<0.001**
Cardiovascular	**Takes medication**	**1.457**	**1.347 to 1.575**	**<0.001**
Primary care (no. visits in last year)	Reference: none			
	1–3	**1.615**	**1.444 to 1.805**	**<0.001**
	4–6	**2.064**	**1.840 to 2.314**	**<0.001**
	7–18	**2.407**	**2.141 to 2.705**	**<0.001**
	>18	**2.526**	**2.179 to 2.928**	**<0.001**
A&E (no. visits in last year)	Reference: none			
	1	1.070	0.985 to 1.163	0.110
	2–3	**1.142**	**1.041 to 1.252**	**0.005**
	>3	**1.336**	**1.188 to 1.503**	**<0.001**

Continued

Table 2 Continued

Parameter	Parameter level	Coefficient RR	CI (95%)	P value
Walk-in unit (no. visits in last year)	Reference: none			
	1–2	0.994	0.908 to 1.088	0.898
	>2	1.002	0.865 to 1.161	0.975
Distance to GP		1.030	0.975 to 1.090	0.291
Distance to A&E		0.999	0.997 to 1.002	0.655
Distance to walk-in		0.999	0.998 to 1.000	0.079
Live alone	Yes	1.056	0.992 to 1.124	0.086
Sense of belonging	Negative	0.953	0.887 to 1.026	0.200

Statistically significant associations are highlighted in bold font.
A&E, accident and emergency; BME, black and minority ethnicities; GP, general practice; IMD, indices of multiple deprivation; RR, relative risk.

more A&E attendances, poorer self-reported health, taking cardiovascular medicine and being an ex-smoker. Being self-defined as BME is significantly associated with a reduced risk in medication count compared with being white with a relative risk of 0.81 (95% CI 0.71 to 0.93, p=0.002). Being in employment is significantly associated with a reduced risk in medication count compared with being unemployed, 0.74 (95% CI 0.69 to 0.81, p<0.001). Regular alcohol consumption is significantly associated with a decrease in medication count (p=0.003).

Findings relating to medication management (online supplemental file: appendices IV and V) indicate that the most common problems people reported, were difficulty with reading the print on the packaging, opening and closing the medication packaging and remembering to take all the medication. These were also the most commonly reported issues in older populations. However, populations reporting extreme polypharmacy were significantly more likely to report difficulties managing to take more than one medicine at a time (χ^2 test p value <0.001). We examined the difference in medication management between those reporting a mental health condition compared with those reporting physical health conditions only. Those reporting a mental health condition were more likely to report difficulties taking their medication (χ^2 test p value <0.001), with higher levels of difficulty reported across all medication management questions. Although the survey does not specify the mental health conditions, in this data set, 79% of those who scored 10 or higher on the PHQ-9 and are defined as depressed or having mental ill health, reported that they were prescribed antidepressant medication (online supplemental file appendices VI and VII). Diagnostic tests were carried out for both of the models considered and results did not suggest a poor fit (online supplemental file appendix III).

DISCUSSION

To our knowledge, this is the first time that polypharmacy has been explored in the context of physical and mental health alongside socioeconomic factors in an adult (18 years and older) household population in North West Coast of England. Additionally, it is the first time that factors associated with increased medication count have been considered in this population.

Findings concur with previous studies that show no difference in level of polypharmacy between males and females. In this study, we found no association between level of education and likelihood of polypharmacy as has been seen in other studies.[12] Furthermore, we did not see an association between income deprivation and polypharmacy when controlling for other socioeconomic factors, including employment status and debt. However, income deprivation was a factor associated with increased medication count when considering the whole sample and living in a deprived neighbourhood was associated with higher odds of reporting extreme polypharmacy. There is limited evidence to support the association between polypharmacy and income, however there is some evidence that costs of prescriptions add to the sense of burden people with long-term conditions experience in relation to their medication.[20] The mechanisms between income and general health have been widely purported, for example, through complex interaction between material, psychosocial, behavioural and biological mechanisms that can influence health outcomes. Although the direct association of income deprivation with increased medication count has not previously been explored, it warrants further investigation. Multimorbidity at an earlier age has previously been associated with increased overall deprivation[5] and this is also the case in specific long-term conditions such as cardiovascular disease,[21] which are also associated with high numbers of comorbidities[22] and polypharmacy. In this study, we found that taking cardiovascular disease medication was associated with polypharmacy, which is unsurprising given that medication for cardiovascular disease can generate a high pill burden.[18]

Age and increased number of health conditions were the strongest predictors of polypharmacy that could be identified and this was greater in cases of extreme polypharmacy, which potentially reflects the availability of more effective treatment regimens for long-term conditions. In the logistic regression there were no notable differences in the frequency of reported primary care use between those on no polypharmacy and those reporting higher levels of prescribed medications. However, those that reported using primary care 1–3 times in the past year, were less likely to report polypharmacy and extreme levels of polypharmacy than those reporting no primary care visits. Typically, those with polypharmacy are multimorbid and use a greater amount of all healthcare services, including both primary care and secondary care.[23] Yet, routine primary care use has the potential to support those with long-term conditions,[24] which is reflected in the NHS Long-Term Plan[24] to address the current challenges faced by the NHS as the ageing, multimorbid population increases. Secondary care is more costly than primary care and primary care is under pressure to deliver increasingly flexible and integrated care,[24] thus services are evolving into Primary Care Networks and are using resources such as the NHS e-referral system advice and guidance and clinical pharmacists to streamline care. Furthermore, the changing community pharmacist role, the rise in specialist clinics to deprescribe, and the increased use of remote and digital healthcare where appropriate also have the potential to provide solutions for increasing the efficient management of multimorbid, polypharmic patients.

Variables associated with no polypharmacy were those that could be characterised as associated with younger aged populations, for example, in employment, in debt and reporting regular alcohol consumption. BME populations were less likely to report high medication counts. These results need to be treated with caution though, as the proportion of respondents categorised as BME was low in the sample.

Factors associated with polypharmacy such as reported quality of life, medication side-effects, depression and high use of A&E are strongly associated with multimorbidity.[23] However, the fact that side effects and high levels of A&E use feature also indicate a potential association with negative repercussions of treatment burden that can increase use of A&E significantly, such as falls.[25] The negative impacts of polypharmacy are also directly associated with self-reported poor quality of life and depression.[6] Findings in this study indicate that those reporting a mental health condition could be more vulnerable to experiencing polypharmacy and subsequently experiencing negative, associated consequences, in line with previously published work.[8] Those with mental illness who are prescribed medication to manage their condition are at increased risk of experiencing drug-interactions,[26] they also report excessive use of emergency healthcare and higher levels of poor self-reported quality of life. Those who were older and those with mental health conditions also reported more difficulties with medication management. This increases the risk of poor medication adherence and compounds the likelihood of experiencing adverse events and subsequent need for A&E services.

Limitations

Data from the Household Health Survey were self-reported and as such were subjected to the recall biases and inaccuracies of respondents. Previous studies exploring self-reported medication have employed more rigorous methods for assessing the accuracy of medication reporting,[27] which we did not have in this study. However, determining prescription medication via interview has been deemed acceptable, particularly for those with long-term conditions and for older age groups.[28 29] Studies considering self-reported medication compared with medical records found a tendency for people to report long-term medication well, but ‘use when needed’ medication less well.[30] Analysis used count data in the binomial model and respondents reporting over 20 medicines were excluded from that analysis to reduce any incidence of misreporting. A total of 35 respondents were excluded based on their reported medication count, which was less than 1% of the responses. Furthermore, we counted the number of medicines a person was taking, which could potentially under-represent the true number wherever combination drugs are taken. However, categorisation of medication count will have minimised the bias in the logistic regression models for both these limitations. In the Household Health study, overall health conditions were self-reported, however, we have no knowledge of the order in which health conditions developed or any means to confirm whether the reported conditions represent formal diagnoses, as such we categorised the data to ensure this was not misreported. Furthermore, mental health conditions are associated with a higher report of medication management difficulties, as are multiple conditions. We note that the classification of ‘depressed’ as having a PHQ-9 scale score of 10 or more distinguishes these respondents as having a level of depression that is relatively severe, and may explain why the mental health conditions analysed were more likely to contribute to reported medication management difficulties.[31]

CONCLUSIONS

The over-riding influences on polypharmacy, particularly extreme polypharmacy, are age and number of health conditions, which concurs with previously published associations. Consequently, the prevention of early long-term conditions may help to prevent or delay the onset of polypharmacy. The association between extreme polypharmacy and higher levels of income deprivation and neighbourhood deprivation supports the view that reducing polypharmacy could be achieved by supporting interventions to reduce the gap in income inequalities and health inequalities generally. More specifically, short term solutions could address the financial expense of, for example, prescription costs for those with long-term conditions who are polypharmic, particularly when on a lower income, in order to increase equitable healthcare provision and prevent financial burden of polypharmacy.[20 32] Now that there is stronger evidence to support the association of polypharmacy with socioeconomic and demographic drivers, more research in this area is needed.

In addition to those taking extreme levels of medication, those that experience mental health conditions appear to have more difficulty with medication management, putting them at increased risk of associated harm. Interventions to prevent mental health conditions, non-pharmaceutical treatments to manage the symptoms of mental illness, and more intense medication management support for those on prescribed medication for mental health conditions may contribute to a reduction in adverse effects. Furthermore, greater support and efforts to deprescribe could benefit both ageing, multimorbid populations and those with mental health conditions.

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Contributors JD, AGM, AA, MP and BB contributed to the design and development of the survey. JD, RT, FD and AA conceived the study idea for this article. All the team developed the concept and defined the research question. JD, RT, FD and AA conceived the design. RT and RM did the analysis and FD contributed to it, JD, MP and AA supported and helped to develop it. JD, RT and FD drafted the manuscript and AA, KD, BB, MP, AGM, TC have critically assessed the document and agreed the final version. FD is guarantor for this study. The corresponding author declares that all the authors meet the criteria for authorship and no others who meet the criteria have been omitted.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by The study was approved by University of Liverpool ethics committee (Ref: RETH000836). Written informed consent was obtained from all participants. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The datasets used in the current study are available to access via application and governance approval (see ARC NWC Household Health Survey – Place-based Longitudinal Data Resource (pldr.org) for details). Further information and data are available from the corresponding author on reasonable request.

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