What factors influence concordance with medications? Findings from the UK Asian Diabetes Study.

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What factors influence concordance with medications? Findings from the UK Asian Diabetes study

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Abstract

Aims To investigate concordance with medication, as assessed at baseline and at 1- and 2-year follow-up, and to examine factors associated with non-concordance in a UK-resident South-Asian population.

Methods Data from the UK Asian Diabetes Study were analysed. Concordance with medications was assessed and recorded at three time points during the study. Multiple logistic regression was used to investigate the factors associated with non-concordance; the associations of baseline factors with year 1 concordance and baseline plus year 1 factors with year 2 concordance.

Results Data for 403 patients from seven practices participating in the UK Asian Diabetes Study were analysed. The numbers of patients who were non-concordant were: 63 (16%) at baseline; 101 (25%) at year 1; and 122 (30%) at year 2. The baseline-measured variables that were significantly associated with year 1 non-concordance included diabetes duration, history of cardiovascular disease, components of the EuroQol quality of life questionnaire, the EQ-5D score, and number of medications prescribed. In multivariable analyses, the most important determinant of year 1 non-concordance was baseline non-concordance: odds ratio 13.6 (95% confidence limits 4.7, 39.9). Number of medications prescribed for blood pressure control was also significant: odds ratio 1.8 (95% confidence limits 1.4, 2.4). Similar results were observed for year 2 non-concordance.

Conclusions Non-concordance with medications was common and more likely in people prescribed more medications. The current target-driven management of risk factor levels may lead to increasing numbers and doses of medications. Considering the high cost of medications and the implications of poor health behaviours on morbidity and mortality, further investigation of prescribing behaviours and the factors affecting patient concordance are required.

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Introduction

Type 2 diabetes is a major public health concern in the UK, particularly in the South-Asian population [1–3]. Poorer self-reported health in this minority ethnic group has been shown to be strongly linked to the use of health services and also to mortality [4]. Specific diabetes management problems for minority ethnic populations include cultural and communication difficulties which make appropriate support of self-care for diabetes (including medication taking) more difficult [5–11]. These issues were highlighted in a prospective study in South-Asian people with Type 2 diabetes which showed that, despite attempts to improve diabetes knowledge and engagement with healthcare services, more work needed to be done to discover why self-management remains poor [12].

A recent report on prescribing for diabetes in England (2011) found that there had been a marked increase in the proportion of all prescriptions written for diabetes and that 'drugs for diabetes' were associated with the greatest increase in cost in primary care in England in 2010/2011, now amounting to 8.4% of total cost of prescribing [13]. This is, for the most part, a response to the target-driven management of diabetes with the continuing 'payment-for-performance' initiative [14].

Diabetes is a complex chronic condition and people with Type 2 diabetes are usually prescribed multiple medicines to improve glycaemic, blood pressure and cholesterol control.

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What's new?

- This study is one of very few to examine the factors associated with non-concordance with medications in people with Type 2 diabetes from minority ethnic backgrounds.
- Our research, in South-Asian people with diabetes, shows the importance of understanding the range of factors that might influence concordance with medications .
- Intensification of treatment may be ineffective where there is already poor concordance with prescribed medications, and alternative strategies for improving self-management need to be identified.
- Given the huge economic cost of polypharmacy, this issue has important implications for both public health and clinical practice.

The effectiveness of this approach has been shown clearly in a number of studies, including the UK Prospective Diabetes Study [12]; however polypharmacy is not without its problems, and there have been several studies which have shown poor concordance with medication where regimens are complex or where multiple medications are involved [15–18]. Other factors associated with non-concordance include the type of medication prescribed [16], poor understanding of the benefits of medication, side effects and poor mental health, particularly where patients report symptoms of depression [19,20].

To date, there has been little non-concordance research in minority ethnic groups. Limited evidence suggests that concordance with medications may be even more problematic because of poor diabetes knowledge and communication difficulties [16]. Social support has also been recognized as an important influence on medication-taking [21] as well as the relationship between doctor and patient; these may be particularly compromised in people from South-Asian backgrounds living in the UK.

In the UK Asian Diabetes Study (UKADS), a large 2-year cluster randomized multiple cardiovascular intervention trial in the community, there was an improvement in blood pressure over time, but no differences in cholesterol or glycaemic control were found [12]. Furthermore, despite enhanced nurse care, link worker assistance and specialist nurse input in the intervention arm of the study, the benefits were limited to small improvements in blood pressure. Possible reasons for this included the potential impact of non-concordance with medications. The aims of the present study were to investigate levels of concordance with medications and to examine the factors that might be associated with non-concordance in the UKADS population.

Methods

The present study aimed to collate and examine the available data on medication, taking into account data on attendance rates and psychological well-being, which had been previously collected on the participants in the UKADS. Full details of the UKADS have been published elsewhere [12]. Briefly, the UKADS comprised a cluster randomized controlled trial conducted in Coventry and Birmingham, UK, during the period March 2004 to April 2007. The UKADS was designed to examine the clinical and cost-effectiveness of a structured, culturally sensitive, enhanced care package for people with Type 2 diabetes from South-Asian backgrounds for the improvement of cardiovascular risk factors and subsequent cardiovascular outcomes [22]. Participants in the intervention arm of the study were seen approximately every 2 months and met with a practice nurse, supported by an Asian link worker and a diabetes specialist nurse. Participants in the control group attended routine 3–6-monthly diabetes clinics led by a practice nurse. At each UKADS visit participants were asked to bring all their medicines with them (in their original containers) as well as any repeat prescription scripts they had. The nurse researcher recorded which medications the participants reported taking, how often they took them and at what level (i.e. number of tablets taken each time). This information was immediately checked with their computerized medical records to ascertain whether the participant's report of the medications they were taking corresponded with the information recorded in their notes or on the medication containers. Any discrepancies were noted on their medical records and were discussed with the participant, with recommendations made if any change in medication-taking was required. Any decisions made were informed by the most recent blood test results and, where required, the participant was asked to make an appointment with their general practitioner.

For the purposes of the present study, concordance with medications was strictly defined as follows:

- Concordance = where the patient reported taking all their medication at the level they had been prescribed (as recorded in their medical records).
- Non-concordance = where the patient reported not taking one or more medications at the level they had been prescribed (i.e. any deviation from prescribed regimen).

A random sample of participating general practices from both the intervention and control arms of the UKADS was identified and the study case notes for each participant in those practices were examined for each year of the study. The data collected included type of general practice (single vs group), number of follow-up visits attended/not attended per year of the study, and the number of medications taken for diabetes, blood pressure, high cholesterol and for other conditions. In the UKADS, urinary albumin:creatinine ratio

was estimated. Overt proteinuria was defined as a urinary albumin:creatinine ratio ≥30.0 mg/mmol for both men and women and microalbuminuria was defined a a urinary albumin:creatinine ratio 2.5 to <30.0 mg/mmol for men and 3.5 to <30.0 mg/mmol for women, with values below these thresholds indicating normal albuminuria [22]. Information on history of previous cardiovascular disease, including coronary heart disease, stroke, peripheral vascular disease and angina was extracted [23]. Participants completed the EuroQol quality-of life questionnaire, known as the EQ-5D, as well as the EQ-5D Visual Analogue Scale (http://www.euroqol.org) at three time points in the study: at baseline and at 1- and 2-year follow-up. The five items of the EQ-5D are designed to measure level of perceived health problems and include mobility, self-care (washing and dressing), usual activities (work, study, housework, family or leisure activities), pain or discomfort and anxiety or depression. Each item is rated separately on a three-point scale: 1, no problems; 2, moderate/some problems; and 3, extreme problems. Higher mean EQ-5D index values and EQ-5D Visual Analogue Scale scores indicate poorer perceived health status. Use of antidepressant medications was recorded, along with information on diagnosis or treatment for psychiatric problems. Country of birth and family history of diabetes were also recorded.

To adjust estimates for deprivation, we used the Index of Multiple Deprivation 2007 [23], extracting an individual score using the standard postcode (postal delivery address), which is a good indicator of individual socio-economic status [24]. The Index of Multiple Deprivation is based on seven domains and is available at small area level (Index of Multiple Deprivation 2007 lower super output level score, obtained using National Statistics Postcode Directory, via GeoConvert: http://geoconvert1.ds.man.ac.uk/application/step1metadata_display.cfm).

Statistical analyses were conducted using SAS. To examine the association between outcomes (non-concordance) at follow-up years 1 and 2 and each of the explanatory variables (measured at baseline or at year 1), frequencies, proportions and comparisons of mean, chi-squared tests, Students *t*-tests and Wilcoxon non-parametric tests were performed as appropriate.

Stepwise selection logistic regression modelling was conducted to identify statistically significant predictors of concordance at year 1, using baseline measures, and at year 2, using year 1 measurements. Models were also evaluated for patients in intervention and control practices separately. To analyse and evaluate combined variables measured at baseline and year 1 on final year 2 concordance status, logistic models were fit using baseline variables and concordance, then changes between baseline and year 1 were added. Hierarchical logistic regression models using SAS PROC GLIMMIX software were also fit. In modelling, to avoid collinearity, individual components of the EQ-5D score were used, but overall score and Visual Analogue Scale score were excluded. Modelling was repeated for the intervention and control arms separately and for total number of medications prescribed vs numbers of medications prescribed for individual conditions.

In the final models (presented), gender, duration of diabetes, HbA_{1c} and family history of diabetes, none of which were included in the automatic selection models processes, were included as potentially confounding variables, irrespective of statistical significance. Linear regression models were used to assess and address issues of collinearity and the final logistic models selected balanced collinearity with highest maximum adjusted R^2 statistic.

Results

The case notes of 403 participants in the UKADS were analysed. At baseline assessment, 84% of study participants were coded as concordant. This proportion fell at each of the following year time points, but with some crossover from non-concordant to concordant status (Table 1, Fig. 1).

Study participants comprised 214 women and 189 men, with a mean age of 55 years and 8 years duration of diabetes. Significant differences between concordant and non-concordant groups at baseline were observed for age, duration of diabetes, total cholesterol and numbers of medications, plus cardiovascular disease history, albuminuria status and missing follow-up appointments. Significant associations were observed between baseline measures and year 1 outcome (concordance status) and between year 1 and year 2 outcomes for a number of other factors, including total EQ-5D scores and the single-item EQ-5D depression/anxiety score, activity score, self-care and mobility scores. Taking a higher number of blood pressure, cholesterol and other medications were all significantly associated with non-concordance (Table 2, Table S1).

Results of multiple logistic regression modelling:

Year 1 non-concordance

In forward selection multiple logistic regression modelling to evaluate baseline predictors of year 1 non-concordance,

Table 1 Concordance status over the study period

	Concordant status, *n* (%)	
Time point	Yes	No
Baseline	340 (84)	63 (16)
Year 1 follow-up	302 (75)	101 (25)
Year 2 follow-up	281 (70)	122 (30)
Summary, *n* (%)		
Fully concordant (all three time points)		259 (64)
Partially concordant (one or two time points)		92 (23)
Always non-concordant (no time points)		52 (13)

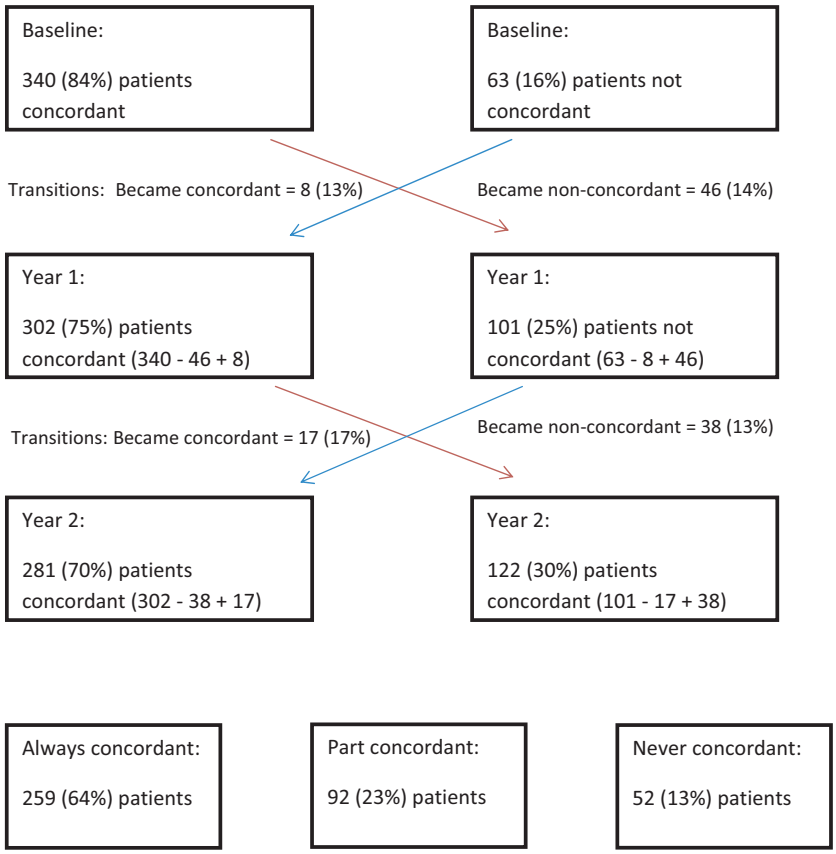

FIGURE 1 403 study patients: Baseline, year 1 and year 2 concordance prevalences, with transitions

five variables were identified: number of blood pressure medications; number of 'other' medications; EQ-5D depression and anxiety score; attained age; and intervention vs control status. The addition of concordance status at baseline into the model identified this as a further factor, with no previously identified factors removed (Table 3). Repeating this analysis, with total number of medications replacing the individual numbers of medications, identified the equivalent set of predictors: baseline concordance status; total number of medications prescribed; EQ-5D depression and anxiety score; intervention vs control status; and age.

Running the same logistic regression in a forward selection procedure for the patients in the intervention and control arms separately identified three significant predictor variables for patients in the intervention arm: baseline concordance; number of blood pressure medications; plus number of 'other' medications, compared with four significant predictors for patients in the control arm: concordance at baseline; number of blood pressure medications; age; and EQ-5D score. Potentially confounding baseline factors (duration of diabetes, family history of diabetes, HbA_{1c} and gender) were added to produce a final predictive model (Table 3).

Non-concordance at baseline, intervention vs control practice status, increasing age, severe EQ-5D depression and anxiety score and higher numbers of medications prescribed to control blood pressure or for 'other' reasons all increased significantly the odds of non-concordance at year 1 follow-up (Table 3). Repeating these analyses using total medications prescribed had no effect on the significance of predictors in the model; odds ratios for all variables increased, except for EQ-5D depression and anxiety score, which decreased.

Year 2 non-concordance

In forward selection multiple logistic regression, using variables measured at year 1 in a predictive model for year 2 non-concordance, only number of blood pressure control medications and EQ-5D depression and anxiety score at year 1 were statistically significant (Table 4). Adding year 1 concordance status and re-running the selection process identified year 1 non-concordance and history of cardiovascular disease only; neither number of blood pressure control medications nor EQ-5D depression and anxiety score remained significant (Table 4). Re-running the selection process for the patients in the intervention and control arms separately identified non-concordance at year 1 for both arms, plus age for the patients in the intervention arm and history of cardiovascular disease for the patients in the control arm.

In the final model, including all variables identified in selection processes plus potentially confounding variables,

Table 2 Association of factors measured at baseline with lack of concordance at year 1

Factor	Concordant at year 1	Non-concordant at year 1	Statistical test
Gender, *n* (%)			
Female	163 (76)	51 (24)	chi-squared = 0.3677, P = 0.5442
Male	139 (74)	50 (26)	
Mean (SD) attained age	53.4 (11.1)	59.3 (11.3)	Difference (95% CI): 5.9 (1.3–11.1) $T = 4.58$, $P < 0.0001$
Mean (SD) duration of diabetes, years	7.4 (6.0)	10.3 (8.3)	Difference (95% CI): 2.9 (0.8–6.6) $P = 0.0092$*
Mean (SD) HbA_{1c} mmol/mol % †	66 (21) (8.2 (1.9))	69 (21) (8.5 (1.9))	Difference % (95% CI): 0.3 (-0.1 to 0.8) $T = 1.41$, $P = 0.1583$
Mean (SD) systolic blood pressure	136.0 (19.0)	144.4 (21.9)	Difference (95% CI): 8.4 (3.9–13.2) $P = 0.0003$*
Mean (SD) diastolic blood pressure	82.4 (9.9)	84.0 (13.0)	Difference (95% CI): 1.6 (-1.2 to 4.3) $P = 0.0980$*
Mean (SD) total cholesterol	4.8 (1.1)	4.6 (1.0)	Difference (95% CI): 0.2 (-0.0 to 0.5) $T = 1.67$, $P = 0.0951$
Cardiovascular disease history, *n* (%)			
Yes	32 (44)	40 (56)	chi-squared = 43.9495, $P < 0.0001$
No	269 (82)	60 (18)	
Albuminuria, *n* (%)			
Normal	216 (76)	69 (24)	chi-squared = 8.0908, $P = 0.0175$
Microalbuminuria	67 (79)	18 (21)	
Overt proteinuria	11 (50)	11 (50)	
Mean (SD) EQ-5D index	0.6 (0.3)	0.5 (0.4)	Difference (95% CI): 0.1 (0.0–0.2) $T = 3.16$, $P = 0.0017$
Mean (SD) EQ-5D Visual Analogue Scale	65.6 (23.0)	57.7 (22.3)	Difference (95% CI): 7.9 (2.4 to 13.5) $T = 2.80$, $P = 0.0054$
Family history of diabetes, *n* (%)			
Yes	165 (77)	50 (23)	chi-squared = 0.8006, $P = 0.3709$
No	137 (73)	51 (27)	
EQ-5D depression and anxiety, *n* (%)			
None	179 (80)	46 (20)	chi-squared = 16.0962, $P = 0.0003$
Mild/Moderate	83 (75)	28 (25)	
Severe	15 (47)	17 (53)	
EQ-5D pain, *n* (%)			
None	81 (81)	19 (19)	chi-squared = 2.6190, $P = 0.2700$
Mild/Moderate	139 (72)	53 (28)	
Severe	57 (75)	19 (25)	
EQ-5D activity, *n* (%)			
None	168 (83)	35 (17)	chi-squared = 17.0295, $P = 0.0002$
Mild/ Moderate	81 (69)	36 (31)	
Severe	26 (57)	20 (43)	
EQ-5D Self-care, *n* (%)			
None	225 (80)	55 (20)	chi-squared = 16.2685, $P < 0.0001$
Mild/Moderate/Severe	52 (59)	36 (41)	
EQ-5D Mobililty, *n* (%)			
None	146 (52)	31 (18)	chi-squared = 6.5352, $P = 0.0020$
Mild/Moderate/Severe	131 (69)	60 (31)	
Blood pressure medications, *n* (%)			
0	126 (95)	7 (5)	chi-squared = 127.0302, $P < 0.0001$
1–2	144 (81)	33 (19)	
3–4	29 (46)	34 (54)	
≥5	3 (10)	27 (90)	
Cholesterol medications, *n* (%)			
0	182 (89)	23 (11)	chi-squared = 42.5702, $P < 0.0001$
1–2	120 (61)	78 (39)	

Table 2 (*Continued*)

Factor	Concordant at year 1	Non-concordant at year 1	Statistical test
Diabetes medications, *n* (%)			
0	97 (78)	27 (22)	chi-squared = 2.1381, *P* = 0.3433
1	103 (76)	32 (24)	
2–3	102 (71)	42 (29)	
Other medications, *n* (%)			
0	171 (84)	33 (16)	chi-squared = 21.1970, *P* < 0.0001
1–2	107 (69)	48 (31)	
≥3	24 (55)	20 (45)	
Missed follow-up appointments, *n* (%)			
No	281 (76)	90 (24)	chi-squared = 2.2677, *P* = 0.1321
Yes	19 (63)	11 (37)	

Missing values: albuminuria, *n* =11; EQ-5D anxiety, *n* =35; EQ-5D pain, *n* =35; EQ-5D activity, *n* =37; EQ-5D self-care, *n* =35; EQ-5D mobility, *n* =35; cardiovascular disease history, *n* = 2, missed follow-up appointments, *n* =2.
*Variances unequal, statistical test was non-parametric Mann–Whitney *U*-test.
†Diabetes Control and Complications Trial-aligned HbA_{1c}
CI, Confidence Interval.

only year 1 non-concordance remained statistically significant, increasing the odds of non-concordance at year 2 (Table 4). Substituting total number of medications prescribed rather than numbers prescribed for blood pressure control increased the estimate and odds ratio for year 1 non-concordance as predictor of year 2 non-concordance which remained significant: odds ratio 27.7 (95% confidence limits 11.2, 68.5), *P*<0.0001. No other variables were statistically significant.

Using forward selection multiple logistic regression with baseline-measured variables, non-concordance, EQ-5D self-care score and number of blood pressure control medications were all significant predictors for year 2 non-concordance (Table 5). Repeating this analysis with changes to concordance status at year 1 from baseline and with changes to numbers of medications prescribed identified the same predictors, plus change in non-concordance status (Table 5). Using a mixed-effects hierarchical model, with fixed effect for baseline concordance and random effect for year 1, baseline non-concordance, number of baseline blood pressure medications and EQ-5D self-care score remained statistically significant: odds ratio for baseline non-concordance 7.1 (95% confidence limits 2.8, 18.5).

Discussion

Rates of prescribing for diabetes are at an all-time high, but it is clear from the present research and that of others that medications are not always taken as recommended [15–18]. Our research shows that, whilst only a small proportion of patients may be continuously non-concordant, individual concordance status may change over time, and this has important implications for practice; for example, in terms of frequency of follow-up appointments to support appropriate medication-taking. An awareness of the impact of taking multiple medications on a daily basis is vital, as is engaging with patients in an open discussion on the importance of self-medicating behaviour and supporting individuals to maximize this aspect of diabetes self-care.

To date, research in South-Asian populations has focused on perceptions of insulin treatment and has shown that there may be a reluctance to move from oral anti-diabetic drugs to insulin therapy [25]. Research in the wider diabetes population has mainly considered how particular aspects of self-management such as diet, physical activity and self-monitoring of blood glucose influence blood glucose control, with less research on the impact of appropriate medication-taking and, specifically, the use of oral anti-diabetic drugs. Those studies that do exist have reported that non-concordance with oral anti-diabetic drugs leads to more hospitalizations and higher mortality rates [26]. The present study showed that, over time, whilst there was some movement from non-concordant to concordant, the overall trend was towards more non-concordance. Whether there are specific benefits for those who are concordant that outweigh any detriment for those who are not concordant remains unknown and requires more in-depth investigation. Furthermore, whether or not those who are non-concordant with their polypharmacy have better or worse outcomes compared with those who are concordant with a regimen consisting of fewer drugs remains unknown.

In the present study, there was no difference between concordant and non-concordant patients at any of the three time points with respect to Index of Multiple Deprivation 2007 score, which was perhaps unexpected; however, it is important to note that average Index of Multiple Deprivation 2007 scores for the patients in the present study were considerably higher than for those in either the Coventry or Birmingham study groups, suggesting that the patients in the present study were more deprived overall. There was no

Table 3 Logistic regression modelling: factors influencing year 1 non-concordance

Variable	Estimate	*P*	Odds ratio (95% CI)
Forward selection procedure			
Non-concordant at baseline vs concordant	2.4265	<0.0001	11.3 (4.1, 31.6)
Number of blood pressure control medications prescribed at baseline	0.6248	<0.0001	1.9 (1.4, 2.5)
EQ-5D depression/anxiety (vs none)			
Mild/moderate	0.2486	0.5302	1.3 (0.6, 2.8)
Severe	2.1561	0.0005	8.6 (2.6, 28.9)
Number of medications for 'other' reasons prescribed at baseline	0.3712	0.0060	1.4 (1.1, 1.9)
Intervention vs control	0.9742	0.0089	2.6 (1.3, 5.5)
Attained age (years)	0.0408	0.0192	1.04 (1.01, 1.1)
Final model with confounders			
Non-concordant at baseline vs concordant	2.6129	<0.0001	13.6 (4.7, 39.9)
Intervention vs control	1.0576	0.0058	2.9 (1.4, 6.1)
Sex (male vs female)	0.4183	0.3836	1.5 (0.7, 3.2)
Attained age (years)	0.0451	0.0176	1.1 (1.0, 1.1)
Duration of diabetes (years)	−0.0203	0.5171	1.0 (0.9, 1.0)
HbA_{1c} (Diabetes Control and Complications Trial-aligned)	0.0994	0.3119	1.1 (0.9, 1.3)
Baseline family history of diabetes (yes vs no)	−0.4830	0.2201	0.6 (0.3, 1.3)
EQ-5D depression/anxiety (vs none)			
Mild/Moderate	0.2994	0.4721	1.3 (0.6, 3.1)
Severe	2.2303	0.0003	9.3 (2.8, 31.4)
Number of blood pressure control medications prescribed at baseline	0.6029	<0.0001	1.8 (1.4, 2.4)
Number of medications for 'other' reasons prescribed at baseline	0.3895	0.0045	1.5 (1.1, 1.9)

CI, Confidence Interval.

Table 4 Logistic regression modelling: factors measured at year 1 influencing non-concordance at year 2 follow-up

Variable	Estimate	*P*	Odds ratio (95% CI)
Forward selection procedure (two models):			
Model 1 - year 1 factors only:			
EQ-5D depression/anxiety at year 1			
Mild/Moderate vs None	0.6763	0.0360	2.0 (1.0, 3.7)
Severe vs None	1.6036	0.0003	5.0 (2.1, 11.8)
Number of blood pressure control medications prescribed at year 1	0.7113	< 0.0001	2.0 (1.7, 2.4)
Model 2 - year 1 factors + year 1 concordance:			
Non-concordant at year 1 vs concordant	3.5460	< 0.0001	34.7 (16.7, 72.1)
History of cardiovascular disease			
Yes vs No	0.9738	0.0206	2.6 (1.2, 6.0)
Final model:			
Non-concordant at year 1 vs concordant	3.1543	< 0.0001	23.4 (9.7, 56.5)
Number of blood pressure control medications prescribed at year 1	0.1309	0.3247	1.1 (0.9, 1.5)
EQ-5D depression/anxiety at year 1			
Mild/Moderate vs None	0.2696	0.4969	1.3 (0.6, 2.9)
Severe vs None	0.5935	0.2876	1.8 (0.6, 5.4)
History of cardiovascular disease			
Yes vs No	0.7510	0.1177	2.1 (0.8, 5.4)
Attained age (years)	0.0113	0.5021	1.0 (1.0, 1.0)
Duration of diabetes (years)	−0.0344	0.1995	1.0 (1.0, 1.1)
HbA_{1c} (Diabetes Control and Complications Trial-aligned)	−0.0450	0.6357	1.0 (0.8, 1.2)
Sex (Male vs Female)	−0.2194	0.5414	0.8 (0.4, 1.6)

CI, Confidence Interval.

significant difference in deprivation score comparing the included general practices, suggesting there was insufficient variation in deprivation in our sample to detect concordance-related differences. Investigation of the relationship between deprivation scores and concordance levels may be a useful avenue for future enquiry.

Table 5 Logistic regression modelling: factors measured at baseline and at year 1 influencing non-concordance at year 2 follow-up

Variable	Estimate	*P*	Odds ratio (95% CI)
Forward selection procedure (two models):			
Model 1 – baseline factors + baseline concordance:			
Non-concordant at baseline vs concordant	1.9473	< 0.0001	7.0 (2.7, 18.0)
EQ-5D self-care at baseline			
Mild/Moderate/Severe vs None	1.0902	0.0016	3.0 (1.5, 5.9)
Number of blood pressure control medications prescribed at year 1	0.5127	< 0.0001	1.7 (1.3, 2.1)
Model 2 – baseline factors and concordance, plus concordance changes at year 1:			
Non-concordant at baseline vs concordant	3.7955	< 0.0001	44.5 (11.0, 179.6)
Change from concordant at baseline to non-concordant at year 1 vs no change	2.7396	< 0.0001	15.5 (6.2, 38.8)
Change from non-concordant at baseline to concordant at year 1 vs no change	−3.6344	0.0008	0.03 (0.003, 0.2)
EQ-5D self-care at baseline			
Mild/Moderate /Severe vs None	1.0062	0.0131	2.7 (1.2, 6.1)
Number of blood pressure control medications prescribed at baseline	0.3482	0.0175	1.4 (1.1, 1.9)
Final Model – baseline factors and concordance, plus concordance changes at year 1 with adjustment for confounding:			
Non-concordant at baseline vs concordant	3.6573	< 0.0001	38.8 (9.4, 159.1)
Change from concordant at baseline to non-concordant at year 1 vs no change	2.6058	< 0.0001	13.5 (5.2, 35.1)
Change from non-concordant at baseline to concordant at year 1 vs no change	−3.4624	0.0024	0.03 (0.003, 0.3)
EQ-5D self-care at baseline			
Mild/Moderate /Severe vs None	0.9218	0.0246	2.5 (1.1, 5.6)
Number of blood pressure control medications prescribed at baseline	0.3412	0.0213	1.4 (1.1, 1.9)
Duration of diabetes (years)	0.0238	0.4026	1.0 (1.0, 1.1)
HbA_{1c} (Diabetes Control and Complications Trial-aligned)	0.0312	0.7532	1.0 (0.8, 1.3)
Sex (Male vs Female)	−0.2962	0.4372	0.7 (0.4, 1.6)
Baseline family history of diabetes (Yes vs No)	0.1821	0.6314	1.2 (0.6, 2.5)

CI, Confidence Interval.

In the present study, non-concordance was associated with taking a greater number of medications (particularly blood pressure medications), which supports previous research [18,27] and has important implications for clinical practice. Previous studies have reported that the polypharmacy required to achieve good glycaemic control is a significant barrier to concordance [27].

Knowledge and understanding of medications may be an important factor influencing concordance [8]. In their study in individuals with Type 2 diabetes, Dunning *et al.* [28] showed that knowledge of medications was poor and 20% of patients regularly forgot to take the medications, with the increasing cost of prescribed medications cited as a reason for deliberately not taking or reducing the dose of medication taken. Surprisingly, the present study did not find a statistically significant association between socio-economic status (potentially related to concerns with the financial cost) and concordance, something that we are not able to explain. Other studies have shown the importance of beliefs about medications with regard to medication-taking [7,10,29]. Future research needs to examine these issues in other minority groups [30].

Patients may take their medications initially, but if the importance of continuing this behaviour is not conveyed during clinical encounters, or if the patient is feeling unwell, he/she may stop taking them. The greater propensity to experience side effects where a high number of medications are taken is not always reported [18] and future studies should include the consideration of side effects in polypharmacy, as this may help explain our findings. This may only be one explanation, albeit an important one. Non-concordance may also be related to the perceived burden of diabetes as well as the number of medications and complexity of the regimen [15,17].

Taking a higher number of cholesterol or diabetes medications was also significantly associated with non-concordance at the univariate level but not in the multivariable analyses. There is some research suggesting that non-concordance with statins increases when overall number of medications is increased, which again suggests that complexity of medication regimen is important [17]. Stack *et al.* [17] suggest that individuals may value the importance of medications differently, prioritising diabetes medications over cholesterol-lowering ones. By contrast, an earlier study reported no consistent difference in concordance with medications based on the type of drugs (diabetes, cholesterol or blood pressure) being taken [18].

Poorer clinic attendance as measured by failure to attend appointments, a further indicator of poor self-care, was also significantly associated with non-concordance, but this effect did not persist in multivariable models. It is of concern that patients appeared to remain disengaged with their healthcare providers as evidenced by poor clinic attendance and what seems to be an unwillingness to take their medications. This may, in part, be related to communication difficulties and poor knowledge of the importance of appropriate

medication-taking, both of which can be addressed in terms of clinical practice.

The most important predictor of non-concordance at both year 1 and 2 year follow-ups was prior concordance status, with a role for number of blood pressure control medications. Furthermore, at year 2, change in concordance status was a highly significant factor, further underlining the importance of continued clinical care and encouraging attendance at clinic appointments. Non-concordance with medication-taking was also significantly associated with poorer perceived health status, as measured by both EQ-5D questionnaire and Visual Analogue Scale. This latter scale is a useful one, especially in populations where there are high levels of illiteracy, such as in the present study population. In particular, those who reported severe anxiety or depression on the EQ-5D also reported poorer concordance with their medications, supporting previous studies [19]. Poor mental health, and especially depression, has been found to be much more common in people with diabetes [31] and has been linked to poor health behaviours, including all aspects of diabetes self-care (blood glucose monitoring, medication taking, etc.) as well as poor attendance at medical appointments [25]. Monitoring psychological well--being is therefore of paramount importance, if positive outcomes in terms of diabetes are to be achieved.

There are limitations to the present study. Our data on prescribed medications relied on the transfer of information from general practitioner medical records to UKADS case notes and the medication list may not be exhaustive. Self-reported concordance/non-concordance may be difficult to measure accurately and it is possible that we may have under- or overestimated non-concordance levels. Indeed, the possibility of participants giving socially acceptable answers regarding their medication-taking may have led to an underestimation of the problem. Other studies have investigated the take up of prescriptions through an analysis of pharmacy claims [15], but this is also problematic, as the filling of a prescription does not guarantee that the medication will be taken. It was possible to check study participants' reports of their prescribed medications using the computerized medical records held for each patient, but we have had to rely on self-report (and on participants bringing their medications and repeat scripts to the consultation) for actual level of medication-taking. We feel that using Asian link workers to collect this information may have assisted this process, however, as these workers were able to develop a rapport with patients that was conducive to an open and engaging consultation between the two parties [32].

The present study, one of the first conducted in one particular group of South-Asian patients, has highlighted the need to address non-concordance with medications, a phenomenon which we have found to be common in this population with diabetes, and which persists over time. Intensification of treatment is ineffective where there is already poor concordance with prescribed medications and alternative strategies for improving concordance with treatment regimen need to be identified. Given the huge economic cost of polypharmacy, alongside its importance in delaying or preventing the development of diabetes complications, this has important implications for both public health and clinical practice. Alternative strategies for increasing/improving diabetes self-management need to be identified.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Association of factors measured at year 1 with lack of concordance at year 2.