Patterns of Family Doctor Decision Making in Practice Context. What are the Implications for Medical Practice Variation and Social Disparities?

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Title:

Clinical Decision Making, Medical Practice Variation, and Social Disparities in Primary Care. The Role of Practice Context

Research Highlights

- Clinical decision making (CDM) is assumed to influence medical practice variation (MPV) and health disparities.
- We investigate the role of practice context in mediating this relationship in primary care.
- We perform a multi-level analysis of clinical activity in a representative sample of New Zealand family doctors and their patients.
- Despite little difference in activity level, MPV was greater for disadvantaged patients and fee-for-service practices.
- CDM may be influenced both by how doctors view patients from different social groups and by the practice context.

Patterns of Family Doctor Decision Making in Practice Context. What are the Implications for Medical Practice Variation and Social Disparities?

ABSTRACT

Medical practice variation and social disparities in health are pervasive features of health care systems. But what impact might everyday clinical decision making have in shaping such aggregate patterns, and could this in turn be influenced by the immediate environment in which family doctors practise? We investigate this by studying inter-practitioner variation in clinical activity across four payment types in New Zealand, a "gatekeeper" primary care system. We do this for four measures of clinical activity by patient ethnic and socio-economic status in a 2001/2 representative sample of 9,272 encounters at 185 family practices. Initial analysis showed little variation in clinical activity either by patient status or by practice type. However, with the application of multi-level statistical techniques it was evident that, while there was still little systematic difference in practitioner activity rates by patient status, inter-practitioner variation was greater for patients of ethnic minority background and from socio-economically deprived areas. Furthermore, this variability was particularly marked in fee-for-service practice settings. Thus, to the extent that family doctor decision-making behaviour within practice context helps shape aggregate patterns of medical practice variation and social disparity, treatment differences are likely associated not with the level of service but with its variability.

Keywords: New Zealand; primary care; medical practice variation; clinical decision making; reimbursement type; social disparity

INTRODUCTION

Medical practice variation (MPV) and social disparities in health are pervasive *macro* features of health systems. But what are the underlying behavioural mechanisms? Could patterns of clinical decision making (CDM) at the *micro* level of the patient encounter, mediated via the *meso* context of the site of practice, play a central role in shaping these aggregate features? This is the fundamental research question being considered in this study and we approach this by determining whether practitioner intervention rates for four common clinical activities (signifying CDM) differ by patient social status in both level and variability (signifying MPV and social disparities), and whether such patterns are in their turn conditioned by practice context (particularly payment and associated organisational arrangements).

Practice variation, social disparities, and decision making

MPV is well-identified at provider, provider group, facility and plan levels and generally accounts for up to 20 per cent of total variability on various performance criteria (Fung et al., 2010). Nevertheless, while such variability has been confirmed cross-culturally (for example, Mousques et al., 2010), and, while connections have been made to the implications for health policy (Davis et al., 2000), the behavioural mechanisms that might underlie MPV have not been widely canvassed.

In a similar vein, the issue of social disparities in health (that is differentials in health or health care by social status) is high on the policy agenda of many developed societies, and authorities have attempted to advance policies to address these (Exworthy et al., 2003).

However, while much has been achieved in the definition and ever-more exact quantification of such disparities, effective interventions to prevent, stabilize or reduce them are hard to find (Mackenbach et al., 2008). There are few if any instances of consciously-designed policy interventions that have successfully addressed them (Starfield & Birn, 2007), and links to mechanisms in care delivery have not often been made.

Yet, it is increasingly being recognized that health care delivery – particularly, in the primary care sector – needs to be included in any comprehensive policy agenda on social disparities (Starfield & Birn, 2007), particularly since primary care is potentially a crucial pathway to equitable social outcomes (Starfield et al., 2005), and there is increasing evidence that health care may indeed make a considerable contribution to improving health outcomes (Nolte & McKee, 2003), likely reducing rather than increasing inequalities of outcome (Tobias & Yeh, 2009).

A key element in any behavioural model of MPV and social disparities - and the possible relationship between them - is the role of the practitioner and patterns of clinical decision making (CDM) since, once the patient has entered the delivery system, the allocation of resources is determined to an important extent by provider actions (for example, this may be particularly likely with variations in preference- and supply-sensitive care (Wennberg, 2011)). In this context, a number of investigators have sought to make a connection between CDM and healthcare disparities (Lutfey et al., 2010), arguing that there may be central features of cognitive framing that can influence provider actions, either consciously or more usually unconsciously, to take account of clinically irrelevant patient characteristics, such as ethnicity, and that this may be influenced by practice context (Burgess, 2010; Lutfey et al., 2008). Other influences identified have been the interaction with the patient (Burgess et al.,

2008), practice style (Mousques et al., 2010), guidelines (de Jong et al., 2010), practitioner perceptions (van Ryn & Burke, 2000), diagnostic certainty (Lutfey et al., 2009), and collegial environment (de Jong et al., 2003).

Site of practice

Practice variation and social disparities, therefore, are notable features of health systems, while the behavioural drivers of these patterns are likely located at the micro level of CDM in myriads of patient encounters. However, such encounters take place in a practice context that may play a role of intermediation and influence. In Figure 1 we present a diagram that captures the key analytical connections between the four elements under discussion: at the aggregate level are well-established macro patterns of both practice variation and social disparity (which may be related to each other), at the encounter level are interactions between practitioners and patients that are likely the behavioural mechanisms for these patterns, and at the meso level is the practice context for such encounters, which may intermediate and influence those drivers.

FIGURE ONE ABOUT HERE

In the current investigation diversity in practice organization (centred around arrangements for practitioner remuneration), and its potential association with patterns of clinical activity for socially-defined groups of patients, is the focus, and the empirical setting is New Zealand since that country provides special conditions for the exploration of the relationship between practice type and CDM. This is so for two reasons. Firstly, it is a publicly-subsidised "gatekeeper" system of primary care, so family doctors play a key role in allocating scarce

resources to patients (Forrest, 2003). Thus CDM is central. Secondly, unusually for a publicly-subsidised gatekeeper system, New Zealand has exhibited considerable diversity of practice organization in primary care, in large part because it has undergone four major restructures of the health care system over the last 20 years (Gauld, 2003). As a consequence of this cascade of reform activity, primary care had by the early 2000s provided a temporary window for this investigation of four reimbursement types (see Box). These ranged from two systems of fee-for-service payment (independent and co-ordinated respectively), through capitation reimbursement, to salaried practices governed by community organizations (Hider et al., 2007).

Insert BOX ABOUT HERE

With this range of practice types in primary care, and given the importance of equity considerations in the New Zealand reform process at the time (Hefford et al., 2005), is it possible in this environment to assess CDM in its relationship both to features of practice context – particularly practitioner reimbursement - and to key criteria of patient social status, namely ethnic and socio-economic status? For example, it might be surmised that fee-for-service and capitated payment systems would be associated with contrasting patterns of care, with the first being linked to more fragmented and less consistent care than the second (Gosden et al., 2001; Keenan et al., 2010; Mousques et al., 2010), and that this might be less conducive to high-quality care for socially-disadvantaged patients (Burgess, 2010).

Hypotheses

This paper seeks to assess these questions through the analysis of patterns of variability in clinical activity in different practice environments and for different categories of patient. To this end, this investigation will adopt a multi-level approach to assessing the association with patterns of clinical activity of practice type, as well as practitioner attributes and behaviour (Aakvik et al., 2010; Davis et al., 2002; Mousques et al., 2010). A key measure of disparity will be the odds ratio representing the relative likelihood of clinical activity for two criterion patient groups, those of ethnic minority background and those living in areas of deprivation (being taken as indicators of social advantage (see Braveman (2006) in measuring disparities). A central consideration of the analysis will be whether this measure varies by practice setting and by practitioner attributes.

Our analysis will be structured around a series of guiding hypotheses.

Hypotheses characterising practice context. Given the role that practice context may play in shaping practitioner decision-making behaviour, we would expect:

1. A strong and distinctive clustering of features for the four practice types, alongside characteristic payment arrangements.
2. Marked differences in levels of clinical activity across these practice types, including by patient status.

Hypotheses characterising practitioner behaviour. Given the role of clinical decision-making as a potential behavioural mechanism, we would expect:

3. That social characteristics of the patient – ethnicity, area deprivation - will be associated with both the level and pattern of clinical decision making.
4. Fee-for-service practices will have higher levels of clinical activity overall - lower for socially disadvantaged patients – and greater inter-practitioner variation.

5. There will be less influence of patient social characteristics on inter-practitioner variation in the more managed practice types, particularly salaried.

These two sets of hypotheses canvass the principal analytical connections in Figure 1 linking practitioner decision-making behaviour at the encounter level to aggregate outcomes of MPV and social disparities, mediated by practice setting.

DATA AND METHODS

This paper analyses patterns of variability in clinical activity in different practice environments and for different categories of patient. Since patient encounters are clustered within providers, after a preliminary descriptive analysis we adopt a multi-level approach to assessing the association of social patterns of clinical activity with practice type, while controlling for practitioner attributes and behaviour (Davis et al., 2002).

Study Design

The National Primary Medical Care Survey was carried out in 2001/2 and followed the general methodology of the National Ambulatory Medical Care Survey in the United States as previously used in New Zealand (NZ) (Raymont et al., 2004). Ethical approval, co-ordinated by the Auckland Ethics Committee, was obtained from ethics committees in all areas around the country represented in the survey.

A nationally representative, multi-stage probability sample of general practitioners, stratified by place and reimbursement/practice type, was drawn. Overall, 70% of practitioners

responded. Each practitioner was asked to provide data on themselves and on their practice, and to report on every fourth of their patients (a 25% sample) in each of two week-long periods separated by an interval of six months. This design would reduce the likelihood of the same patient being sampled more than once. A total of 244 practitioners participated and provided patient visit data on 9,272 encounters at 185 family practices across four practice types. The visit questionnaire recorded data about the patient, his or her problems and their management. Other questionnaires obtained data on practitioner and practice characteristics respectively. This paper reports on visits during week-day office hours Monday to Friday 8am-6pm (and excludes commercial clinics specialising in episodic care and usually open outside standard business hours (Hider et al., 2007)).

Description of Variables

Patient characteristics were: age (years); gender (male, female); self-reported ethnicity (not NZ European [mostly Maori and Pacific people] (abbreviated to non-European), NZ European (abbreviated to European)); and deprivation level (deprived: NZDep2001 quintile 5, not deprived: NZDep2001 quintiles 1-4) where NZDep is a small area index of deprivation based on residential address (Salmond & Crampton, 2002) and used as a proxy for an individual-level measure of deprivation (Krieger et al., 2002).

Diagnosis was taken to be the primary diagnosis and classified into 14 categories using READ version 2 chapters (NHS Connecting for Health, 2011) containing more than five percent of visits. Other variables associated with the diagnosis were: whether it related to a long-term problem (judged by the practitioner), the number of diagnoses per visit (1, 2 or more), and severity (also judged by the practitioner).

Practitioner characteristics were: age (years), gender (male, female), and ethnicity (not NZ European, NZ European (abbreviated to non-European and European, respectively).

Practice characteristics were: practice type (independent and co-ordinated fee-for-service, capitated, or salaried), practice size (number of full-time equivalent doctors and nurses), hours open per week, and urban/rural location, and a quality management score representing the sum of positive responses on a series of descriptors (written policy: on complaints, on critical events investigation procedures, on training for staff, on development for staff, on ongoing quality management; utilisation: of peer review process, of evidence-based protocols/guidelines).

The **outcomes** or dependent variables were the likelihood of clinical intervention: investigation – orders for laboratory tests and imaging (yes/no); prescription (yes/no); follow-up requested within 3 months (yes/no); and referral – to medical or non-medical practitioners or hospital emergency department (yes/no). We defined the level of clinical activity as the percentage of patient visits at which a specific clinical intervention occurred.

Measures of social disparity used to form patient groups were*:* ethnicity (not NZ European, NZ European (abbreviated to non-European and European, respectively)), and residential deprivation (deprived, not deprived).

Statistical analysis

We carried out a preliminary descriptive analysis (Tables 1 and 2) to set the foundation for the complex analyses to follow. We show age- and gender- adjusted odds ratios of clinical activity by patient group as a bridge to the results of the full multilevel models. We then fitted, using SAS software (SAS Institute Inc, 2004) a series of generalised linear mixed models. Multi-level logistic regression was applied to patient visits data from 244

practitioners. Patient visits (level 1) were considered to be nested within practitioner (level 2) which was set up as a random effect. 'Practice' was not considered as a third level because essentially there was only one practitioner from each practice. The following variables featured in the analysis:

- Clinical activity outcomes were: investigation, prescription, follow-up, and referral.
- Diagnostic covariates were: primary diagnosis, long-term problem, number of diagnoses (1, 2 or more), and severity.
- Patient covariates were: age, gender, ethnicity, and deprivation. Note that deprivation was never used as both an individual-level (micro) and social disparity (macro) variable in the same multilevel model.
- Practitioner and practice characteristics were not included in the final models as they were not statistically significant. It was also thought that including practitioner identity as a random variable would capture the practitioner effect better and also allow generalisation to the population of practitioners.

We introduced practitioner and patient identities as random effects, with patient and diagnosis covariates as fixed effects. By specifying in the model that the intercept and also the coefficient of, say ethnicity, are random, we have assumed that the baseline and the effect of the variables in the model are different for each practitioner. This is a random slope model where the relationship between practitioner and clinical activity outcome is allowed to vary according to patient ethnicity (or deprivation).

We distinguish two sets of multilevel models corresponding to the two patient groupings reflecting social disparity, i.e. ethnicity and deprivation respectively. Where ethnicity was

included as a random effect, deprivation was included as a fixed effect; and where deprivation was included as a random effect, ethnicity was included as a fixed effect.

The following two measures were derived from the multi-level analysis (adjusted for patient-level factors): variance components; median rates and inter-quartile range.

Variance components were calculated as the percentage of total variance explained by the linear predictor (the fixed effects), patient level and practitioner level respectively, and are presented in bar graphs (Figure 2). We adopted variance components analysis to show particularly the relative contribution at the practitioner level. We wanted to examine not only if there were disparities by social group in levels of health care but also if there were differences in the variance components due to the practitioner. Details of how these were calculated (Snijders & Bosker, 1999) are outlined in a Statistical Addendum and the tabulated data are available in a web-accessible Appendix (Table1A) (Electronic Supplementary Material (online publication only)). [INSERT LINK TO ONLINE FILES]

Median rates - a function of the intercept **- and inter-quartile ranges** of clinical activity overall and by practice type were calculated to capture the random practitioner effects. We considered these measures to be more readily interpretable. In the first instance we plot the distribution around the overall average of practitioners' rates of clinical activity for different patient groups (Figure 3). We then present graphs of the key information on median rates and inter-quartile ranges by patient status and practice context (Figure 4). The tabulated data (Table 2A) and the plotted distributions by practice type (Figures 1A-4A) are available in the web-accessible Appendix (Electronic Supplementary Material (online publication only)). [INSERT LINK TO ONLINE FILES] Figures showing distribution curves have been produced using R software (R Development Core Team, 2009).

RESULTS

Table 1 provides basic descriptive information on practice, practitioner and patient characteristics. Salaried practices were concentrated in urban settings, had more practitioners, many of whom were not New Zealand European by origin (henceforth abbreviated to non-European), and treated patient populations that were both young and overwhelmingly of minority ethnic group background and from deprived residential areas. By contrast, a third of independent, fee-for-service practices were in rural areas, had fewer staff, their practitioners were older and predominantly of European background, and they treated patients of an average to advantaged socio-demographic profile. The other two practice types were somewhere between these two. A score on quality management items shows clear variability between practice types; thus, there is a progressively more structured and explicit approach to quality management, as shown by the increasing mean score, moving across the table from independent fee-for-service to salaried practice.

TABLE ONE ABOUT HERE

In Table 2 further descriptive information is provided with data on clinical activity levels presented across three panels. The first panel displays clinical activity - as a percentage of encounters, adjusted for age and gender - across four output classes and shows that there was little systematic difference between practice types in this output measure, although salaried practices had the highest levels. Panels two and three present odds ratios of clinical activity by ethnic group and residential area deprivation, adjusted for age and gender. Again there was little systematic difference in activity odds ratios or patterns by practice type. It is notable that in only two cases – referral (for ethnicity) and investigation (for residential area

deprivation) - were the marginal values of the odds ratios both less than one (indicating lower levels of clinical activity for disadvantaged patients) though not statistically significant.

TABLE TWO ABOUT HERE

Because of the nested nature of the data – patients within doctors – it was necessary to apply multi-level techniques. This provided an opportunity to assess the distribution of variance in clinical activity, rather than absolute levels, across measured variables (fixed effects) and across both patients and practitioners. The results of overall variance decomposition from a "random slope" analysis are presented in Figure 2.

FIGURE TWO ABOUT HERE

As can be seen, the proportion of variance allocated at the practitioner level was large, rivalling the contribution of the patient variance component. Furthermore, the size of the practitioner contribution tended to be greater for non-Europeans and for those living in deprived areas; for these groups it varied between 40 and 60 per cent, while the range was 18 to 28 per cent for patients of European background and those not living in deprived areas. Conversely, patient effects were much greater for the latter two groups (55 to 70 per cent), and much lower for the former (30 to 45 per cent). Apart from prescribing for Europeans, in no case did the contribution of the fixed effects amount to more than a fifth of overall variability, and in all cases this contribution was less for the two socially-disadvantaged patient groups than their respective comparison groups.

These results suggest there is considerable variability in activity at the practitioner level, and this differs by patient status. This is considered in Figure 3 where the vertical axis represents the proportion of practitioners, and practitioner rates for each clinical activity are plotted together in a separate graph for each patient group. As can be seen, average rates did not differ markedly across patient group but the distributions of practitioner intervention rates are much "flatter" for non-European patients and those living in deprived areas, suggesting greater variability in activity rates for these groups.

FIGURE THREE ABOUT HERE

How is the amount of variation in clinical activity influenced by practice type? Here we use measures of the average (median) and dispersion (inter-quartile range) to describe the distributions of practitioner for rates of activity, and these are represented by graphs in Figure 4. In the graphs – one set for the ethnic comparison by practice type within clinical activity, and the other by deprivation status – it is possible to compare median (height of the dots) and inter-quartile range (dispersion measure as shown by the whiskers).

FIGURE FOUR ABOUT HERE

For independent fee-for-service practices the inter-quartile range varied between 0.50 and 0.87 for the two socially disadvantaged (criterion) groups and 0.34 and 0.50 for their comparators (European, non-deprived). By contrast the comparable ranges for salaried practices were 0.29-0.37 (criterion) and 0.32-0.43 (comparator). In other words, measures of dispersion were non-overlapping between these two practice types from different ends of the practice spectrum for the criterion (i.e. disadvantaged) groups, but largely consistent for their

comparators. Overall there is strikingly little variation in practitioner rates of clinical activity by patient ethnicity or deprivation for salaried practices compared to the independent fee-for-service, with the other practice types in an intermediate position.

DISCUSSION

Principal Findings

At the height of the reform period of the 1990s New Zealand developed a number of practice types in primary care (see Box), thus providing a window of opportunity for this investigation. The focus of the analysis was on the extent to which patterns of care might be socially selective and mediated via site of practice (Figure 1).

We specified five guiding hypotheses, broadly as follows:

1. A strong and distinctive clustering of features for the four practice types.
2. Correspondingly marked differences in levels of clinical activity.
3. Patient social status associated with the pattern of clinical decision making.
4. Fee-for-service practices with higher levels of clinical activity overall - lower for socially disadvantaged patients – and greater inter-practitioner variation.
5. Less influence of patient social disadvantage on inter-practitioner variation in the more managed practice types, particularly salaried.

Descriptive information confirmed that the four practice types differed strikingly in practice and patient profiles (Table 1) (thus confirming our hypothesis one), yet clinical activity showed little consistent difference by practice type and rarely indicated lower rates of

treatment for socially disadvantaged patients (Table 2) (thus failing to confirm our hypothesis two).

In a multi-level logistic regression analysis of clinical activity, the fixed effects – the measured attributes of patients and their diagnoses – generally accounted for less than a fifth of the overall variance, and were much weaker for patients from the two socially-disadvantaged groups. Conversely, for the random effects analysis, variance at the practitioner level was substantial – about half – and much greater for these two groups (Figure 2). This was also reflected in notably discrepant distributions of practitioner intervention rates by patient status for all clinical activities (Figure 3). These findings largely support our hypothesis three (role of patient social characteristics).

Once practice type was brought explicitly into the analysis it was evident that, while median rates of activity differed slightly across practice type or by patient social group, practitioner variability around the median was generally twice as great for patients from the two criterion groups, in part confirmation of our hypothesis four. Furthermore, this difference was more marked for practitioners working in independent fee-for-service settings and less for those in salaried practice (Figure 4), confirming our expectation for hypothesis five.

Implications

This study has implications for our understanding of the impact that professional and practice factors can have on clinical decision-making in primary care and the role that this behavioural mechanism may have in shaping aggregate patterns of practice variation and social disparity.

In the context of the debate on whether primary care mitigates or exacerbates social differentials, the results of this study are mixed. Social disparities in clinical activity were not clearly evident which confirms other findings (Dixon et al., 2007). On balance, therefore, this study suggests that, while ethnic (Blakely et al., 2005) and socio-economic (Blakely & Wilson, 2006) inequalities in health outcomes are clearly evident and marked in New Zealand, as elsewhere (Mackenbach et al., 2008), social selectivity in clinical decision making in everyday primary medical care does not seem to work consistently or strongly to reinforce those wider inequalities. Nevertheless, the greater variability of practitioner decision-making for socially disadvantaged patients, particularly in fee-for-service settings, may provide support for the role that practitioner behaviour and practice context may play in shaping aggregate patterns of practice variation and social disparity. However, it should also be noted that differentials in access to, and utilization of, primary care are not accounted for in this study.

While social selectivity in clinical decision making in primary care is not strongly or consistently evident in this study, it casts new light on the potential role of professional and practice factors in influencing patterns of clinical activity. Therefore, while social disparities in the *absolute* rates of clinical activity were not evident, practice and practitioner variables were associated with the social patterning of clinical activity. Thus, practitioner *variability* in clinical decision-making was much more marked on all four activity measures for the two criterion patient groups (those of non- European background and those living in areas of deprivation), which may provide confirmatory evidence for a cognitive load model of the link between CDM and social disparities (Burgess, 2010). In other words, on this argument, the intrinsically high cognitive demands made of practitioners in the clinical encounter are further exacerbated by the requirements of interaction with patients from other social

backgrounds. This means that practitioners may have difficulty processing relevant clinical information for socially disadvantaged patients, and this greater degree of uncertainty may in turn be reflected in more variable decision-making.

More than this, practitioner variability in decision-making was also associated with practice setting. Thus, for the two criterion groups, salaried practitioners showed the least variability in clinical decision-making and fee-for-service practitioners the most, while for the two comparator patient groups the pattern of clinical decision-making was largely the same for these two practice types. Practitioners under capitation or in co-ordinated fee-for-service practices were generally intermediate between these two extremes (i.e. there was a gradient of effect across the ordered practice types).

While inter-practitioner variation in decision-making is well established, and has been shown to vary by patient status (van Ryn & Burke, 2000), with little evidence of practice determination (O'Neill & Kuder, 2005), what has not been demonstrated before is differences in such dispersion by patient group and practice type. Indeed, to the extent that differences in dispersion – rather than inter-practitioner variation per se – have been studied, it has been shown not necessarily to differ in hypothesized directions (de Jong et al., 2010). Our results, therefore, point to potential explanations for recorded differentials in treatment that may also help understand variability in treatment, such as clinical uncertainty and barriers to communication (McGuire et al., 2008), reinforcing the views of others that practice-level interventions offer an opportunity to address social disparities in treatment (Miranda et al., 2003).

Strengths and limitations

A key strength of the study is that it is based on data from a large, nationally representative sample of primary care practitioners and their patient visits, permitting a multi-level analysis. The overall response rate was favourably high at 70%.

A weakness of the study is the exclusion of after-hours treatment, and ambulatory care provided at commercial clinical and hospital emergency departments. Also, the analysis is susceptible to a strong selection effect, since practitioners – and, with them, their patients - opted into the different practice settings. However, this would, if anything, have enhanced practice effects, which, apart from dispersion, were little evident in this study.

Another study limitation relates to the adequacy of the data collection method though data were recorded by doctors immediately after each patient visit with high item response. A sub-study of electronic compared to paper-based methods on doctors seeing patients with similar characteristics showed evidence that a tailored paper-based approach elicited greater response for certain data items than did routinely-collected information via patient management systems (Crampton et al., 2007).

CONCLUSIONS

Conventional analyses of inter-practitioner variation relying on clinical activity outcomes that are not adapted for social disparity may not capture important contributions to variability in clinical decision-making. While there was little evidence in this primary care sample of systematic bias in clinical activity level by patient social group, practitioner variability was much more marked for patients drawn from ethnically and socio-economically disadvantaged

backgrounds. This was also influenced by practice setting. Thus, to the extent that family doctor decision-making behaviour within practice context helps shape aggregate patterns of MPV and social disparity, treatment differences are likely associated not with the level of service but with its variability, since it is the greater dispersion in clinical activity for socially disadvantaged patients and in fee-for-service settings that are the striking outcomes of this investigation.

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Statistical Addendum. Calculation of variance components

Let Y_{ij} be the dichotomous outcome that results when the ith patient is treated by the jth doctor, and let x_{1ij}, x_{2ij} … and z_{1j}, z_{2j}, … represent potential predictor variables. Here the x_{hij}s are measured at the patient level, and the z_{hj}s are measured at the doctor level, For simplicity of exposition, we first consider the case where there is just a single patient-level variable, x_{ij}, and a single doctor-level variable, z_j.

The procedure assumes that Y_{ij} is determined by an underlying threshold model based on a latent variable Y^*_{ij} which can be expressed in the form

$$Y^*_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + b_{0j} + b_{1j} x_{ij} + r_{ij},$$

where β_0, β_1 and β_2 are fixed parameters, b_{0j} and b_{0j} are random intercepts and slopes, respectively, at the doctor level and r_{ij} is.a random (patient-level) residual. We assume that the random variables b_{0j}, b_{1j} and r_{ij} all have mean zero, that r_{ij} is independent of $\begin{pmatrix} b_{0j} \\ b_{1j} \end{pmatrix}$, and that neither $\Sigma_b = \begin{pmatrix} \sigma_0^2 & \sigma_{01} \\ \sigma_{01} & \sigma_1^2 \end{pmatrix}$, the covariance matrix of $\begin{pmatrix} b_{0j} \\ b_{1j} \end{pmatrix}$, nor σ_r^2, the variance of r_{ij}, depend on x_{ij} or z_j. Estimates of the unknown parameters, β_0, β_1, β_2, σ_r^2 and Σ_b can then be obtained using the SAS Glimmix procedure (SAS Institute Inc. 2004), under the additional assumptions that b_{0j} and b_{1j} are normally distributed and that r_{ij} has a logistic distribution. Note that Y_{ij} is not affected if Y^*_{ij} and the threshold are multiplied by an arbitrary constant, so the parameters in the model are only determined up to a scale factor. It is customary to choose the scale so that r_{ij} has a standard logistic distribution and hence that $\sigma_r^2 = \pi^2 / 3$.

Let be Y* be the outcome, and x and z the covariate values, of a randomly chosen patient treated by a randomly chosen doctor. Then, using the standard relationship between conditional and unconditional moments, i.e. $Var\{Y^*\} = Var\{E(Y^* \mid x, z)\} + E\{Var(Y^* \mid x, z)\}$,

we can partition $Var\{Y^*\}$ into three components, say $Var\{Y^*\} = \sigma_F^2 + \tau_2^2 + \sigma_r^2$, where σ_F^2 is the variance of the linear predictor, $F = \beta_0 + \beta_1 x + \beta_2 z$, $\tau_2^2 = Var\{b_0 + b_1 x\}$ is the level 2 variance, attributable to differences among doctors, and σ_r^2 is the residual (patient-level) variance. Recall that we can only estimate the relative values of the variances rather than their absolute values. However, this is enough to enable us to estimate the proportion of variance explained by the model (i.e. by the linear predictor), $\sigma^2_F/(\sigma^2_F + \tau^2_0 + \tau^2_{1+}\sigma^2_r)$, the proportion of variance attributable to differences among doctors, $\tau^2_2/(\sigma^2_F + \tau^2_{2+}\sigma^2_r)$, and the proportion of variance attributable to residual differences among patients, $\sigma^2_r/(\sigma^2_F + \tau^2_{2+}\sigma^2_r)$.

Extending the model to cope with more covariates is straightforward. The fixed effects part of the model for Y* becomes $F = \beta_0 + \sum_h \beta_{1h} x_h + \sum_h \beta_{2h} z_h$ and we can include any patient level variables that we want in the random component to give $b_0 + \sum_h b_{2h} x_h$.

Box. Features of New Zealand's primary care system in the early 2000s

The New Zealand health care system is largely funded by government from general taxes, and has been consistently so since the 1930s (Hefford et al., 2004). Within this tax-funded system primary care is provided by private General Practitioners (Family Doctors), who receive a government subsidy per patient, as well as patient co-payments. Access to hospital and specialist services is by referral from family doctors, a so-called "gate keeper" system (Forrest, 2003).

As a result of over a decade of health reform activity New Zealand primary care in the early 2000s supported the following major practice types:

1**. Independent** sites of solo and group practice largely unchanged from the traditional pattern.

2. Practices **co-ordinated** by Independent Practitioner Associations (IPAs) with a modicum of structure but retaining traditional fee-for-service payment.

3. **Capitated** practices in IPAs under contract to funding authorities.

4. Practices governed by community organizations (including Māori, the indigenous people), staffed with **salaried** employees and under quite prescriptive contracts to funding authorities.

This diversity in payment system has since been superseded in the mid-2000s by a more uniform blending of capitation and fee-for-service, reduced co-payments, patient enrolment, and elements of community consultation (Hefford et al., 2004).

Figure captions

Figure 1. Practice context mediates the macro-level effects of clinical decision making

Figure 2. Multi-level analysis of rates of clinical activity by patient group: Variance components for fixed and random effects

Figure 3. Variation in practitioner rates of clinical activity by patient group

Figure 4. Variation in practitioner rates of clinical intervention for patient group by practice type: median and interquartile range

Table 1. Practice, Practitioner and Patient Characteristics by Practice Type

	Practice type				Total
	Fee for Service		Capitated	Salaried	
	Independent	Co-ordinated			
PRACTICE CHARACTERISTICS					
N (percent distribution) [a]	33 (23.1%)	77 (48.0%)	57 (26.7%)	18 (2.3%)	185 (100%)
Location					
- City (%)	61.6	67.8	12.4	72.2	51.7
- Town (%)	4.0	4.7	49.0	16.7	16.6
- Rural (%)	34.4	27.5	38.6	11.1	31.7
Number of practitioners (mean)					
- Full-time equivalent doctors	1.6	2.3	2.3	2.7	2.1
- Full-time equivalent nurses	1.0	1.7	1.7	2.4	1.5
Access to practice - Hours open per week (mean)	50.1	49.0	48.0	44.2	48.9
Quality management score: mean (std deviation)	2.1 (4.7)	3.0 (4.1)	4.2 (2.9)	5.1 (1.6)	3.2 (4.0)
PRACTITIONER CHARACTERISTICS					
N (percent distribution)	39 (19.3%)	86 (51.6%)	74 (26.4%)	45 (2.7%)	244 (100%)
Age group 45+ (%)	68.4	42.0	38.9	35.6	46.1
Gender – Male (%)	61.7	63.5	61.8	68.9	61.8
Ethnicity - European (%)	71.5	70.1	66.0	55.6	68.9
PATIENT CHARACTERISTICS					
N (percent distribution)	1441 (16.8)	3623 (53.9)	3194 (27.8)	1014 (1.5)	9272 (100%)
Age group 65+ (%)	19.4	23.4	21.7	14.3	22.1
Ethnicity - Non-European (%)	25.0	21.1	30.9	71.2	25.3
NZDep2001 - most deprived quintile (%) [b]	13.0	15.8	31.0	55.6	20.2

[a] Percentages and means have been adjusted to account for sample design. Missing data have been excluded from calculations.
[b] NZDep2001 is a measure of residential area deprivation.

Table 2. Levels of Clinical Activity and Odds Ratios by Practice Type

	Practice type				Total
	Fee for Service		Capitated	Salaried	
	Independent	Co-ordinated			
PRACTICE CHARACTERISTICS					
N (percent distribution) [a]	33 (23.1%)	77 (48.0%)	57 (26.7%)	18 (2.3%)	185 (100%)
LEVEL OF CLINICAL ACTIVITY [b]					
Investigation (%)	26.3	25.6	23.2	30.0	25.1
Prescription (%)	67.1	64.2	67.5	72.0	65.8
Follow-up (%)	54.9	52.9	54.8	65.8	54.1
Referral (%)	15.6	16.2	16.8	25.4	16.2
ODDS RATIOS FOR CLINICAL ACTIVITY – ETHNIC BACKGROUND [c]					
Investigation	1.06	1.05	0.97	1.38 *	1.03
Prescription	1.52 *	1.10	1.34 *	1.26	1.26*
Follow-up	1.26	1.25	0.96	0.99	1.15
Referral	0.90	0.88	0.82	1.25	0.88
ODDS RATIOS FOR CLINICAL ACTIVITY – AREA DEPRIVATION [c]					
Investigation	0.85	0.90	0.85	0.89	0.88
Prescription	0.92	1.33 *	1.30 *	1.05	1.28*
Follow-up	1.49	1.15	0.86	1.21	1.07
Referral	1.93 *	0.84	1.00	1.00	1.02

[a] Percentages and odds ratios have been adjusted to account for sample design. Missing data have been excluded from calculations.
[b] Percentages are adjusted by age and gender (standardized to New Zealand Census population 2001)
[c] Odds ratios, adjusted by age and gender, were estimated by multiple logistic regression models using SAS 9.1 Surveylogistic procedure (SAS Institute Inc., 2004). The reference groups are 'NZ European' for ethnic background, and 'Not Deprived' for area deprivation.
* $p<0.05$.

Figure 1 Practice context mediates the macro-level effects of clinical decision making

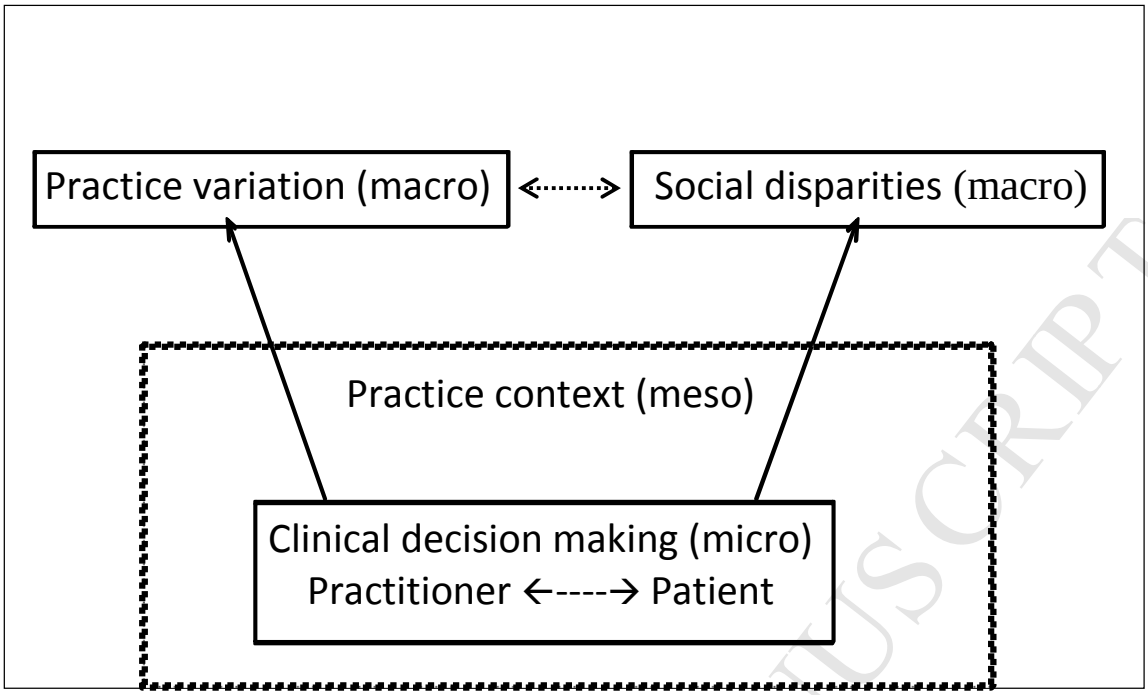


Figure 2

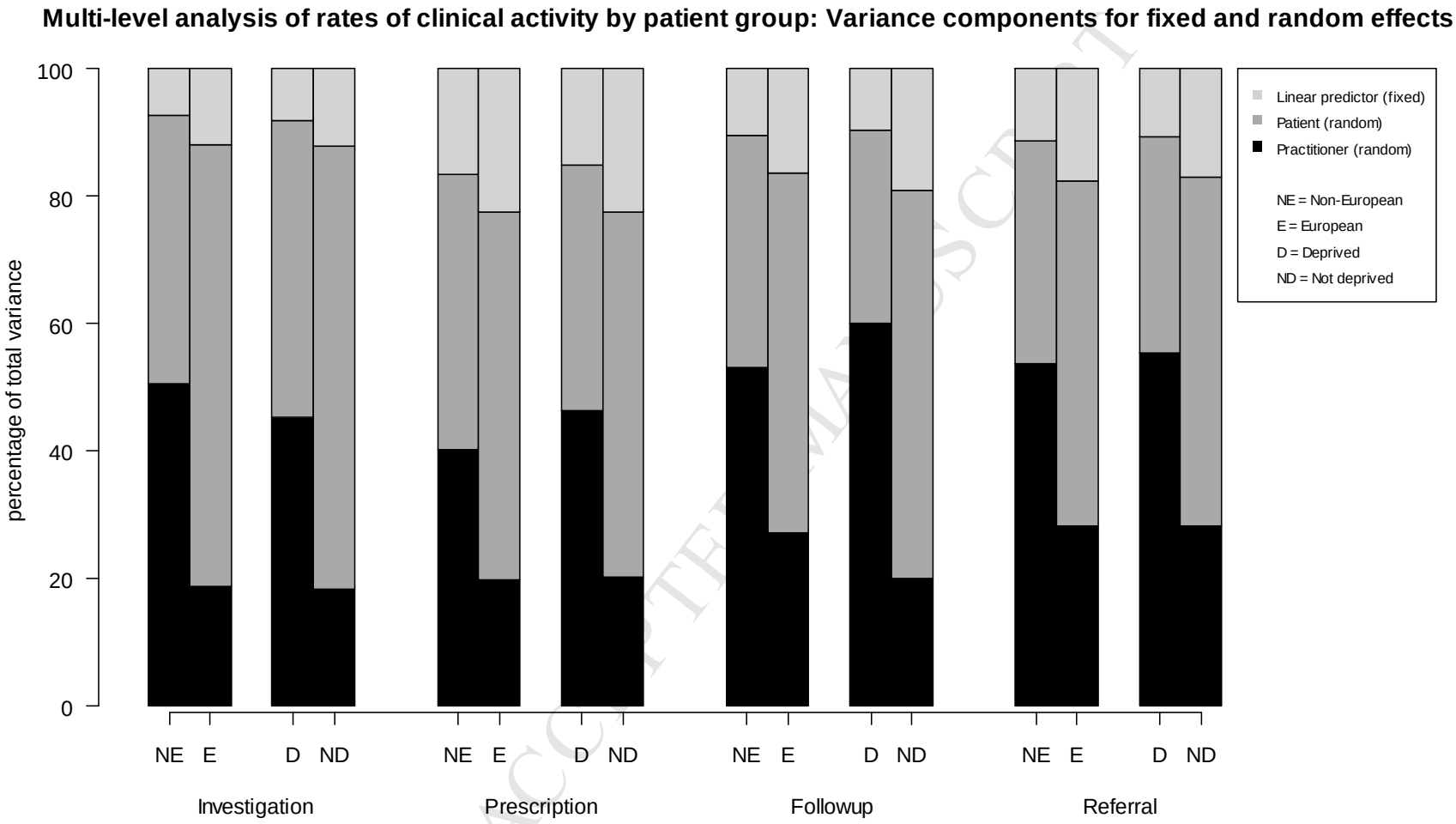
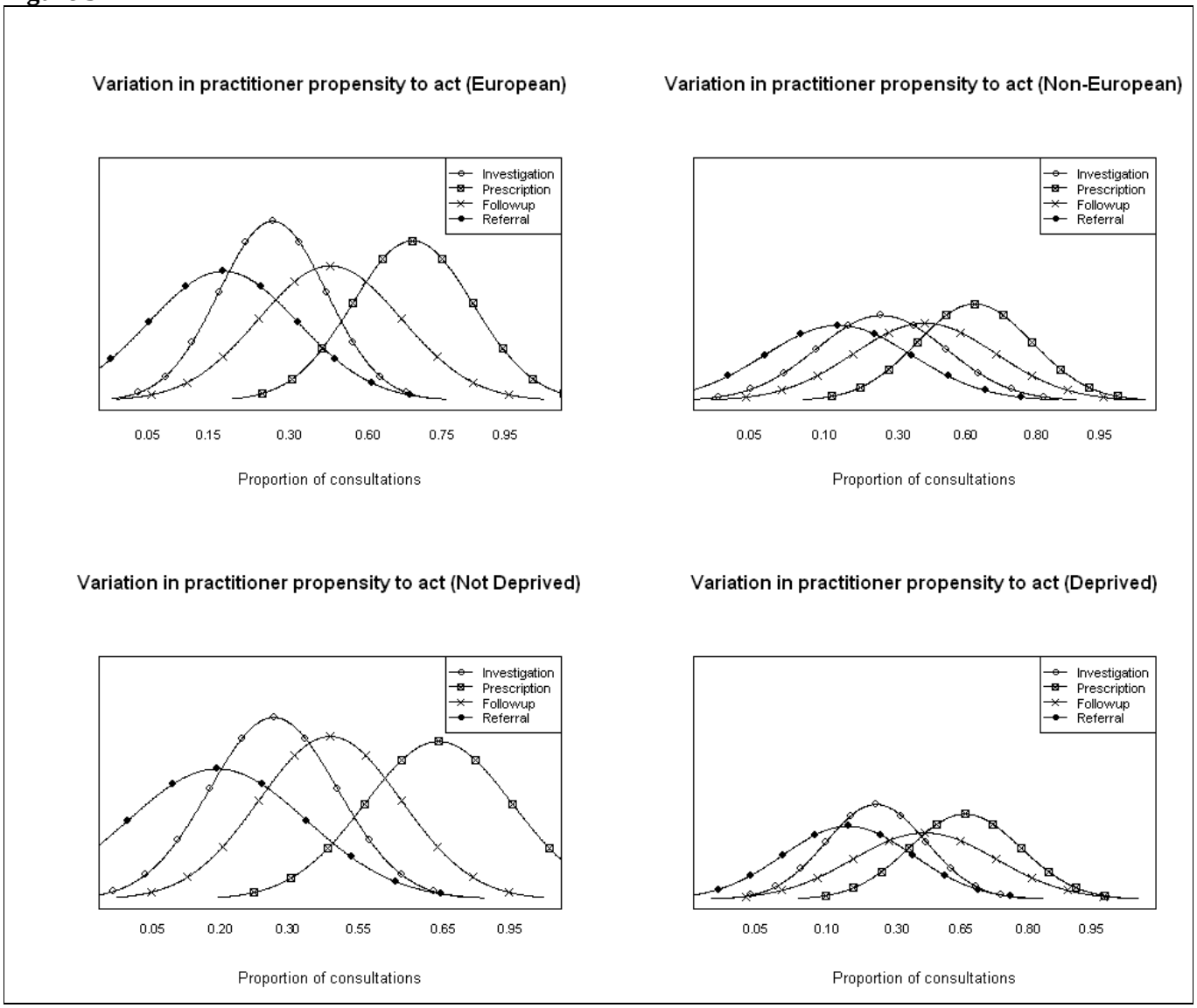


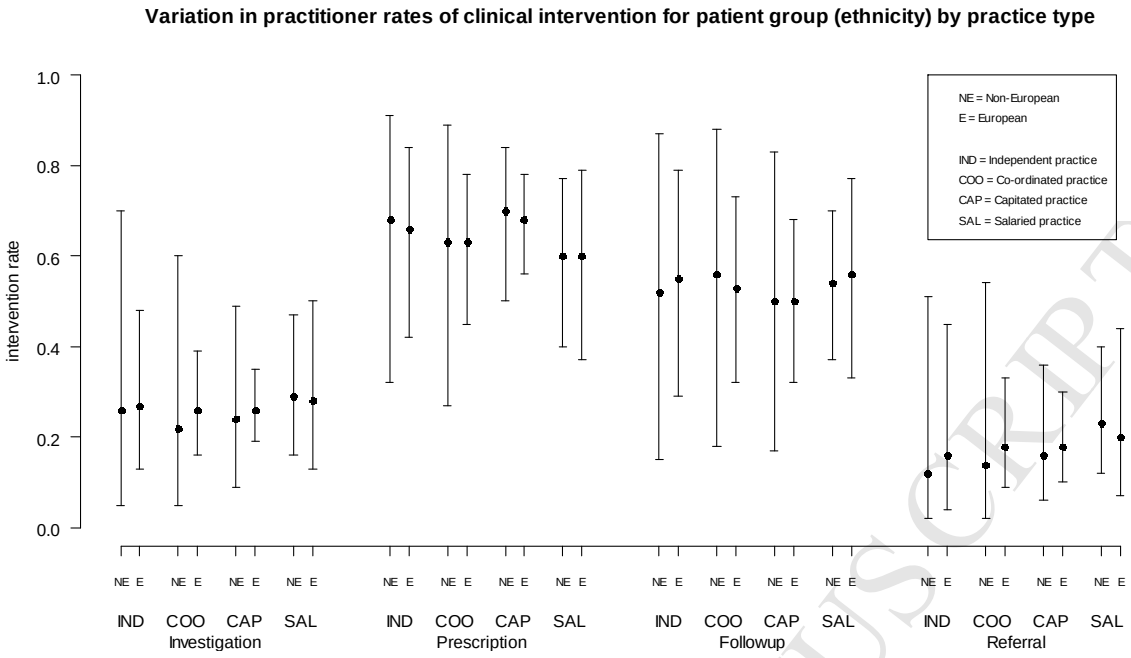
Figure 3

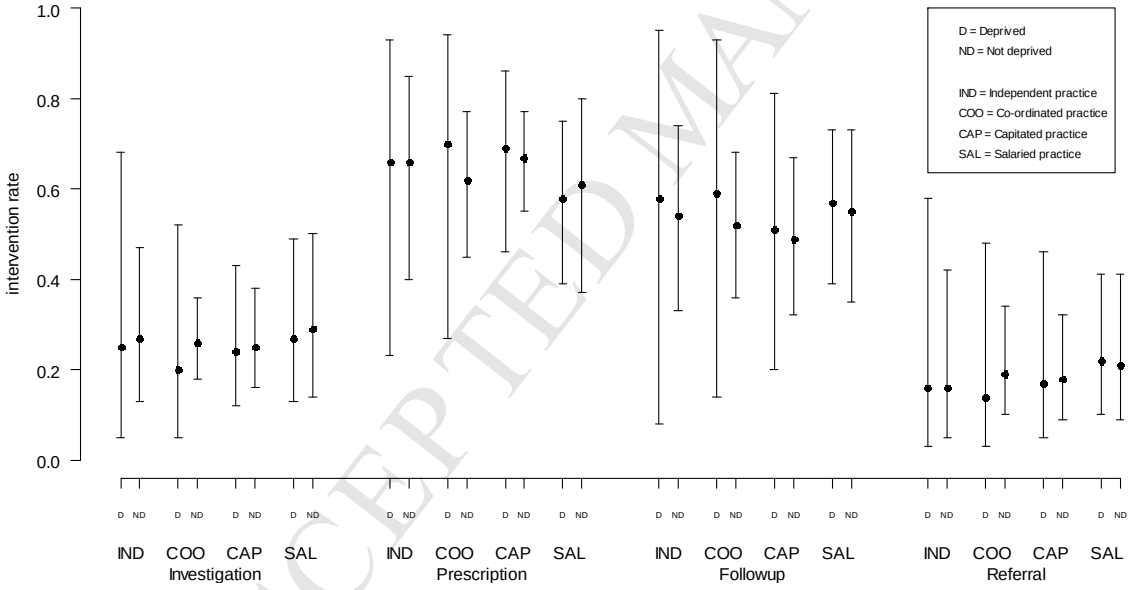


1. Adjusted for case-mix and age

2. Tick marks on the x-axis are on the logit scale

Figure 4





Title:

Clinical Decision Making, Medical Practice Variation, and Social Disparities in Primary Care. The Role of Practice Context

Appendix (Electronic Supplementary Material (online publication only))

Table 1A. Multi-level analysis of rates of clinical activity by patient group: Variance components for fixed and random effects

Logit model (Random slope) [a] **Random effects:** Patient & practitioner **Fixed effects:** Patient & diagnosis variables	**CLINICAL ACTIVITY:** **Percentage of total variance**							
Patient Group	**Investigation**		**Prescription**		**Follow up**		**Referral**	
ETHNICITY	*Non-European*	*European*	*Non-European*	*European*	*Non-European*	*European*	*Non-European*	*European*
Practitioner (random)	50.6	18.8	40.2	19.7	53.0	27.1	53.7	28.2
Patient (random)	42.1	69.2	43.1	57.8	36.5	56.5	34.9	54.2
Linear predictor (fixed)	7.3	12.0	16.8	22.5	10.5	16.3	11.4	17.6
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%
DEPRIVATION	*Deprived*	*Not deprived*	*Deprived*	*Not deprived*	*Deprived*	*Not deprived*	*Deprived*	*Not deprived*
Practitioner (random)	45.2	18.3	46.3	20.1	60.0	20.0	55.4	28.1
Patient (random)	46.7	69.5	38.6	57.5	30.4	60.8	34.0	54.8
Linear predictor (fixed)	8.2	12.2	15.0	22.4	9.6	19.3	10.6	17.1
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%

[a] SAS 9.1 Glimmix procedure (SAS Institute Inc., 2004)

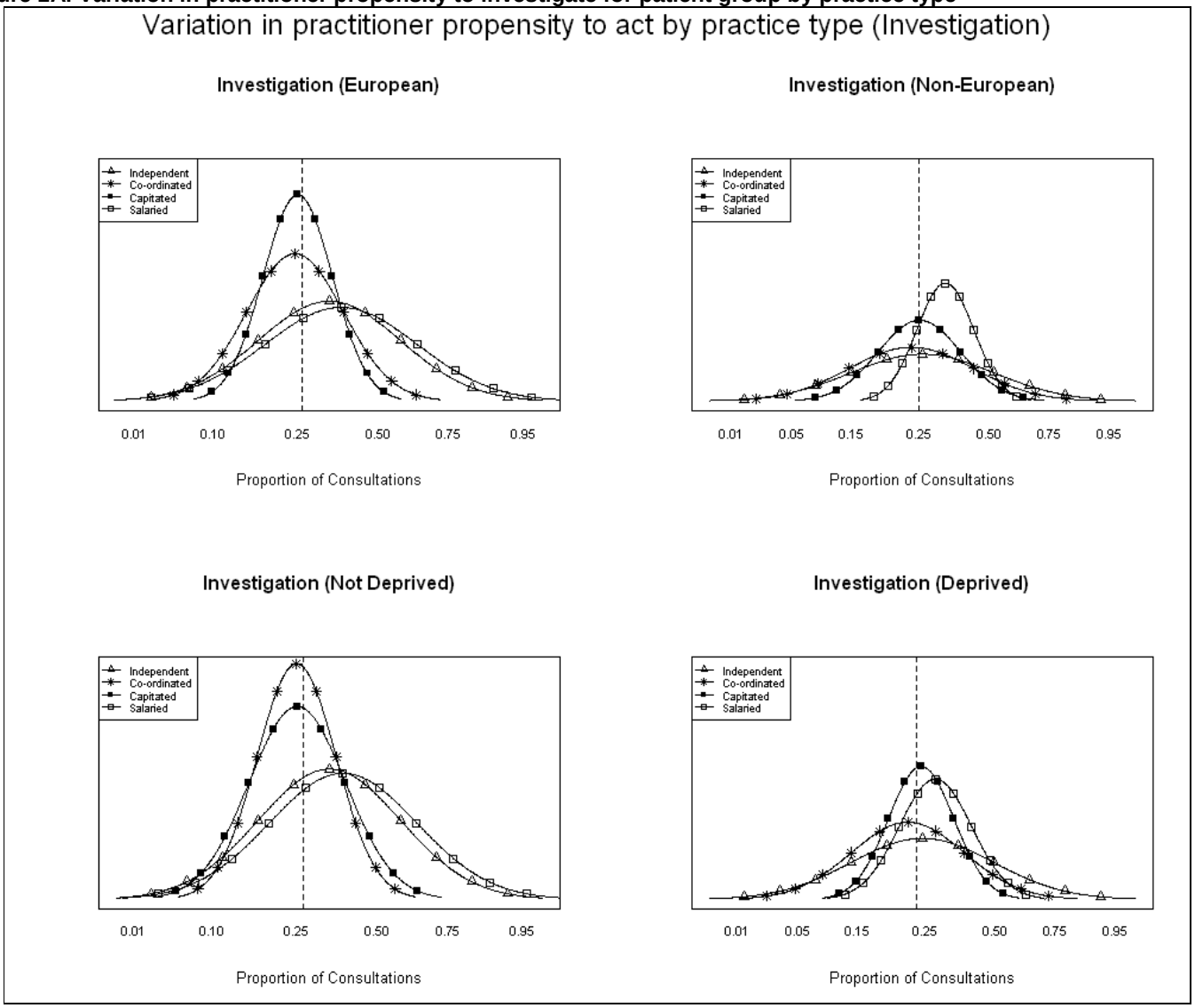
Table 2A. Variation in practitioner rates of clinical intervention for patient group by practice type: median and interquartile range

Practice Type	Investigation		Prescription		Follow-up		Referral	
	Non-European	*European*	*Non-European*	*European*	*Non-European*	*European*	*Non-European*	*European*
Clinical Intervention Rate - Median Proportion* of Consultations for Patient Group								
All Practices	0.24	0.26	0.66	0.64	0.54	0.53	0.15	0.18
Independent	0.26	0.27	0.68	0.66	0.52	0.55	0.12	0.16
Co-ordinated	0.22	0.26	0.63	0.63	0.56	0.53	0.14	0.18
Capitated	0.24	0.26	.070	0.68	0.50	0.50	0.16	0.18
Salaried	0.29	0.28	0.60	0.60	0.54	0.56	0.23	0.20
Interquartile Range of Clinical Intervention Rate for Patient Group								
All Practices	0.08 – 0.55	0.16 – 0.40	0.37 – 0.86	0.47 – 0.78	0.21 – 0.84	0.33 – 0.72	0.04 – 0.45	0.08 – 0.35
Independent	0.05 – 0.70	0.13 – 0.48	0.32 – 0.91	0.42 – 0.84	0.15 – 0.87	0.29 – 0.79	0.02 – 0.51	0.04 – 0.45
Co-ordinated	0.05 – 0.60	0.16 – 0.39	0.27 – 0.89	0.45 – 0.78	0.18 – 0.88	0.32 – 0.73	0.02 – 0.54	0.09 – 0.33
Capitated	0.09 - 0.49	0.19 - 0.35	0.50 – 0.84	0.56 – 0.78	0.17 – 0.83	0.32 – 0.68	0.06 – 0.36	0.10 – 0.30
Salaried	0.16 – 0.47	0.13 – 0.50	0.40 – 0.77	0.37 – 0.79	0.37 – 0.70	0.33 – 0.77	0.12 – 0.40	0.07 – 0.44

Practice Type	Investigation		Prescription		Follow-up		Referral	
	Deprived	***Not Deprived***	***Deprived***	***Not Deprived***	***Deprived***	***Not Deprived***	***Deprived***	***Not Deprived***
Clinical Intervention Rate - Median Proportion of Consultations for Patient Group								
All Practices	0.23	0.26	0.68	0.63	0.55	0.52	0.16	0.18
Independent	0.25	0.27	0.66	0.66	0.58	0.54	0.16	0.16
Co-ordinated	0.20	0.26	0.70	0.62	0.59	0.52	0.14	0.19
Capitated	0.24	0.25	0.69	0.67	0.51	0.49	0.17	0.18
Salaried	0.27	0.29	0.58	0.61	0.57	0.55	0.22	0.21
Interquartile Range of Clinical Intervention Rate for Patient Group								
All Practices	0.08 – 0.50	0.16 – 0.40	0.36 – 0.89	0.45 – 0.78	0.18 – 0.87	0.35 – 0.69	0.04 – 0.48	0.08 – 0.35
Independent	0.05 – 0.68	0.13 – 0.47	0.23 – 0.93	0.40 – 0.85	0.08 – 0.95	0.33 – 0.74	0.03 – 0.58	0.05 – 0.42
Co-ordinated	0.05 – 0.52	0.18 – 0.36	0.27 – 0.94	0.45 – 0.77	0.14 – 0.93	0.36 – 0.68	0.03 – 0.48	0.10 – 0.34
Capitated	0.12 – 0.43	0.16 – 0.38	0.46 – 0.86	0.55 – 0.77	0.20 – 0.81	0.32 – 0.67	0.05 – 0.46	0.09 – 0.32
Salaried	0.13 – 0.49	0.14 – 0.50	0.39 – 0.75	0.37 – 0.80	0.39 – 0.73	0.35 – 0.73	0.10 – 0.41	0.09 – 0.41

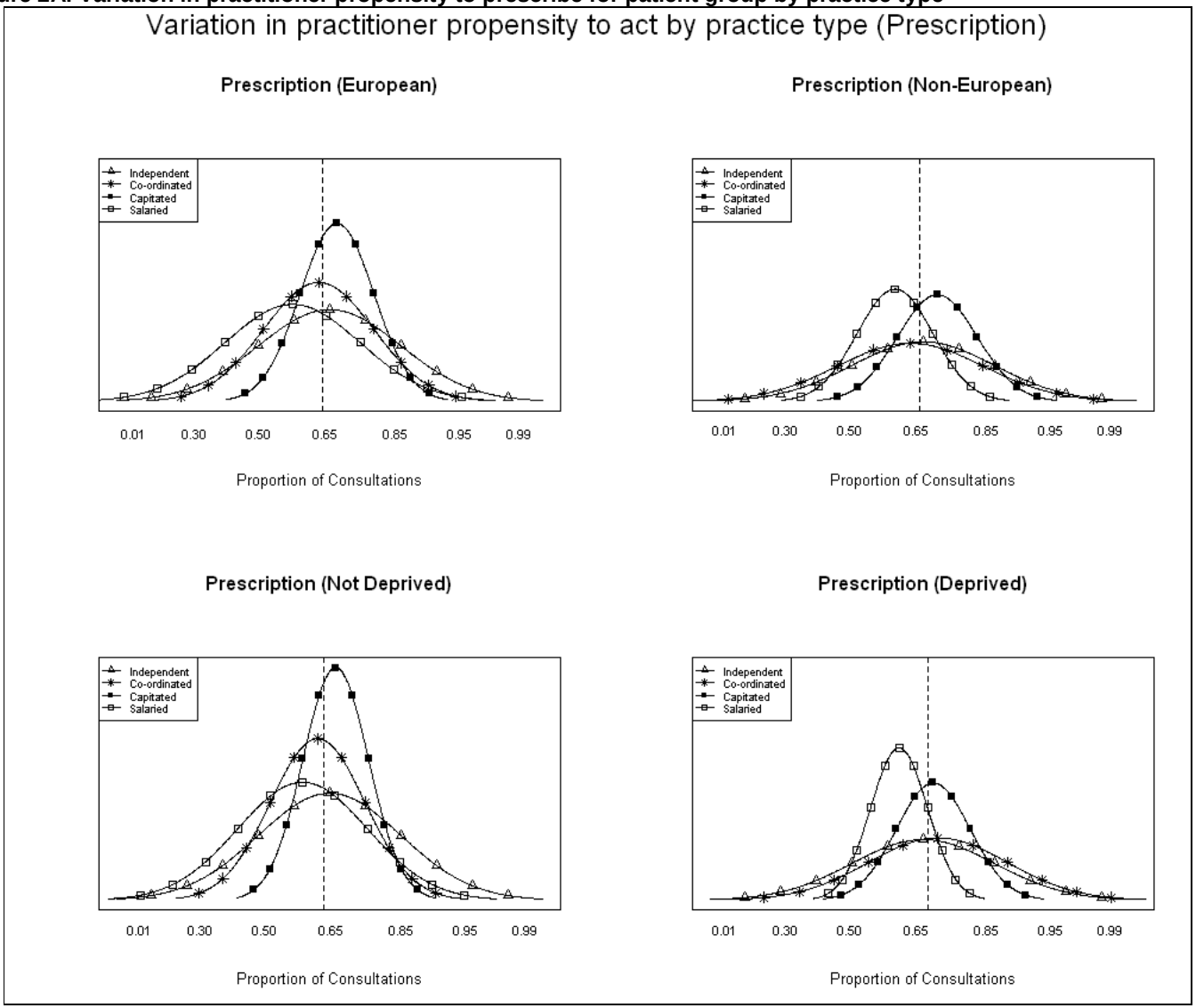
* Calculated as a function of the intercept adjusted for case-mix and age.

Figure 1A. Variation in practitioner propensity to investigate for patient group by practice type



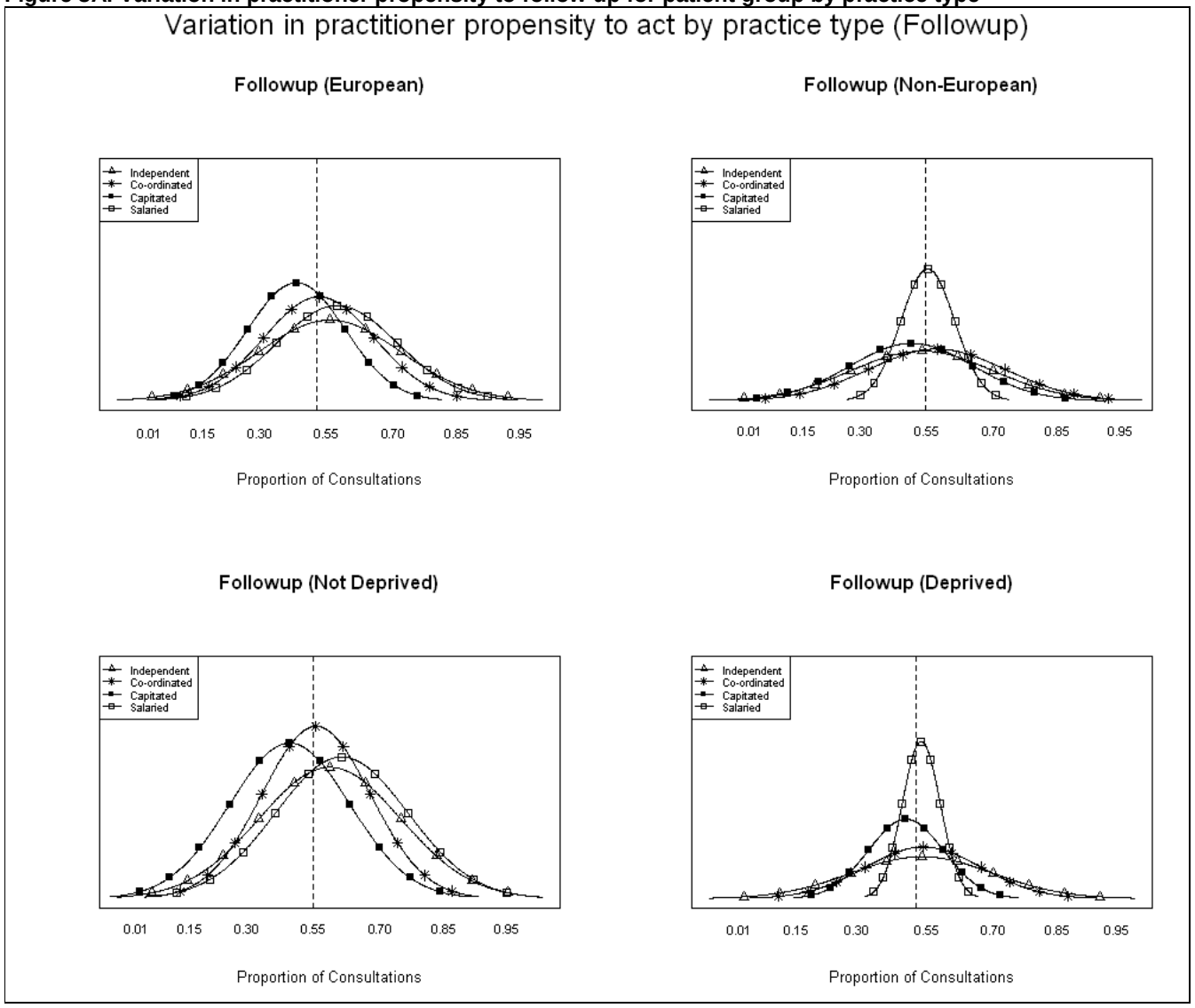
1. Dotted line indicates median proportion of consultations for each patient group
2. Adjusted for case-mix and age
3. Tick marks on the x-axis are on the logit scale

Figure 2A. Variation in practitioner propensity to prescribe for patient group by practice type



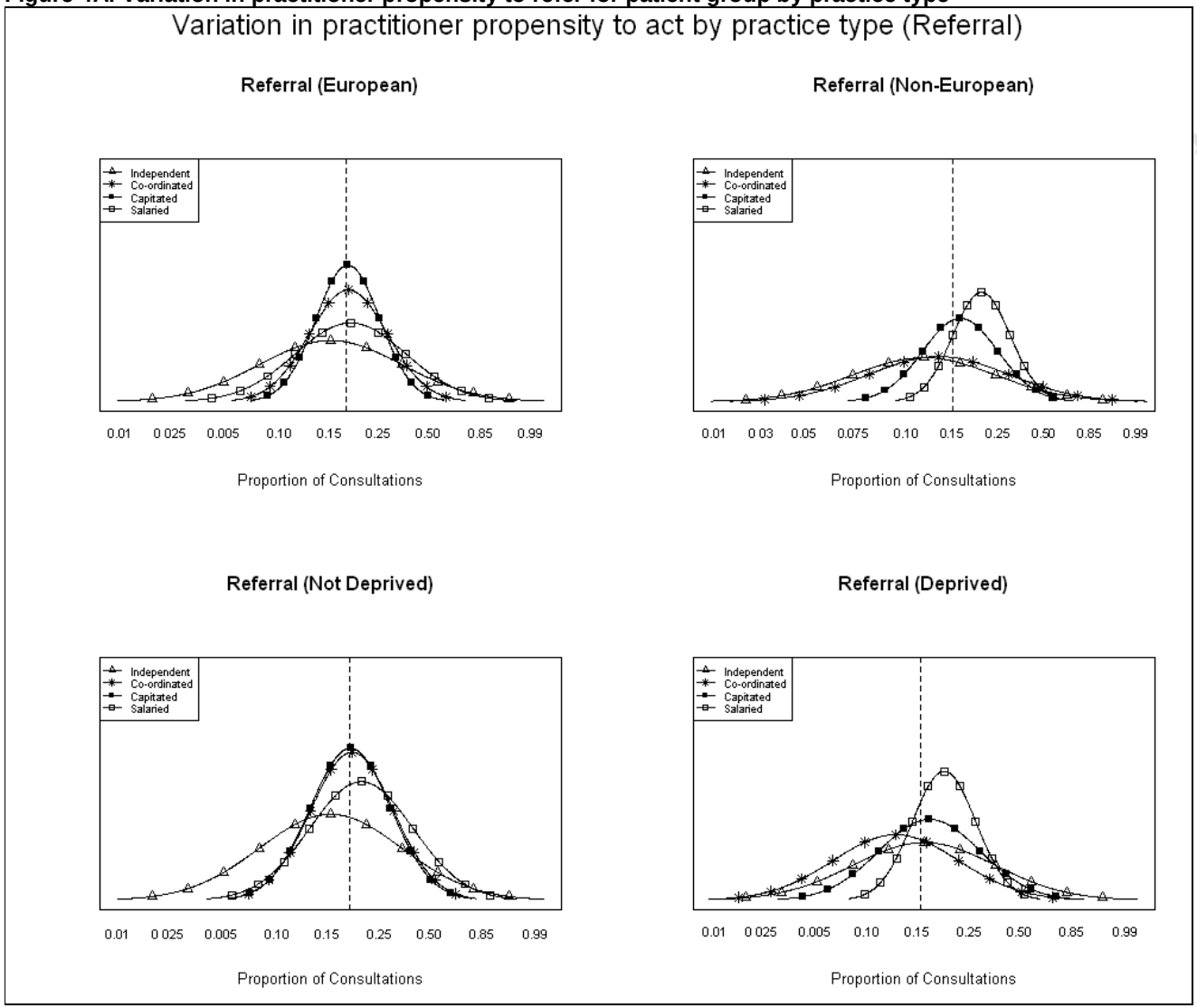
1. Dotted line indicates median proportion of consultations for each patient group
2. Adjusted for case-mix and age
3. Tick marks on the x-axis are on the logit scale

Figure 3A. Variation in practitioner propensity to follow up for patient group by practice type



1. Dotted line indicates median proportion of consultations for each patient group
2. Adjusted for case-mix and age
3. Tick marks on the x-axis are on the logit scale

Figure 4A. Variation in practitioner propensity to refer for patient group by practice type



1. Dotted line indicates median proportion of consultations for each patient group
2. Adjusted for case-mix and age
3. Tick marks on the x-axis are on the logit scale