The accuracy of age-sex registers, practice medical records and family practitioner committee registers

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SUMMARY. This paper presents the results of a point prevalent evaluation of the comparative reliability and validity of age-sex registers, practice medical records and family practitioner committee (FPC) registers from five teaching practices. They all exhibited similar levels of acceptable accuracy for patient names, sex and age, but the distribution of wrong addresses varied greatly: practice medical records 3·9 per cent, age-sex registers 8·2 per cent and FPC registers 17·1 per cent. The presence of a patient entry in all three registers was associated with a high degree of probability (95·3 per cent) that this individual would be a *bona fide* practice patient. The register population inflation rates were FPC records 5·5 per cent, practice records 9·8 per cent and age-sex registers 10·6 per cent, but there were large variations between individual practices. A statistically significant contribution to inflation rates came from the age groups 0 to 1 and 21 to 40 ($p<0·0005$). The register population deflation rates were minimal. The significance of these findings is discussed and the need for practices to determine the accuracy of their individual age-sex registers is stressed. A convenient and economic method for so doing is suggested. We also suggest ways of making it easier to construct and use age-sex registers, since they can be a most versatile and useful aid to research in general practice.

© *Journal of the Royal College of General Practitioners*, 1981, 31, 410-419.

Introduction

THE age-sex register (ASR) was primarily developed because it is so valuable in research, and it has come to be recognized as "a feature of British general practice" (*Journal of the Royal College of General Practitioners*, 1977). Not only can age-sex registers provide an index of the total practice population by age and sex, they can also be used as a sampling frame for the whole population or for population subsets. In addition, they can identify matched controls (Russell, 1975) and can provide valuable information about the logistical feasibility of projects at the design stage. The age-sex register is potentially the most valuable tool in general practice research, being far superior to the two other major sources of information about general practice populations, namely practice medical record envelopes (MREs) and family practitioner committee (FPC) medical records.

The MREs are usually filed in alphabetical order with sexes mixed, and can provide only a total practice population by a lengthy process of counting; they cannot be used as an age-sex specific sampling frame or a population subset denominator.

The FPC medical register is a series of alphabetically ordered sex-mixed card indices of all persons registered with each individual general practitioner who is in contract with the FPC. These cards are filed under the heading of each doctor's name. Again, this register is useful mainly for a total population count, although the numbers of patients between 65 and 74 years of age and those over 75 are also available from it and are communicated quarterly to general practitioners. It cannot be used as an age-sex specific sampling frame or as a

population subset denominator, except in the over 65s; even then it does not provide a sex differentiation.

The age-sex register is also increasingly being used for screening purposes. Indeed, the Expenditure Committee of the House of Commons (1977) has stated its support for "the setting up and maintaining of age-sex registers in order to identify those at risk among a general practitioner's patients". Over 1,000 British practices probably now have an age-sex register, of which over half are likely to be in active use. It has been estimated that about half the practices use their registers for screening purposes at any one time, mainly checking on immunization and cervical cytology, and about one third for research (Goodman, 1975). British general practitioners with an age-sex register appear, therefore, to be in a uniquely favourable position to undertake good quality research and surveillance because they are responsible for a numerically defined population and know the age-sex distribution of that population.

However, an age-sex register is useful for research only if it is accurate, otherwise "the whole exercise will be a complete waste of time, money and energy" (Goodman, 1975). Evidence has previously been presented which raises doubts about the reliability and validity of population registers in general practice (Fraser, 1978). The need for further data was stressed and two parallel prospective studies, one point prevalent, the other longitudinal, were outlined. This paper will describe the findings of the point prevalent study.

Hypotheses and aims

Our hypotheses were:

1. Age-sex registers may be no more reliable or valid than other population files in general practice.

2. Age-sex registers will contain patient-characteristic information which is inaccurate even for *bona fide* patients. (A *bone fide* patient is defined as being traceable in the practice area and regarding the practice as his or her source of medical care.)

3. Cards will be present in age-sex registers even when the patient is known to have left the practice or is untraceable.

4. *Bona fide* practice patients will exist without being represented by cards in the age-sex register.

5. Variables affecting the above can be identified and measured.

6. Levels of accuracy will vary between practices.

Our aims were as follows:

1. To determine the point reliability and validity of age-sex registers compared with other population registers in general practice.

2. To quantify the comparative population 'inflation' and 'deflation' of the registers. ('Inflation' is defined as the proportion of patients present in the various registers, but not traceable as *bone fide* patients; 'deflation' refers to the proportion of patients who have been traced as being present in the practice area, appearing in one or more registers, but absent from the particular register quoted.)

3. To identify the most accurate method of making and using an age-sex register.

Methods

The study was carried out in five Leicester teaching practices with a population of some 50,000 patients in urban, rural and mixed areas. The FPC responsible for the majority of patients was Leicestershire FPC, but one practice also had patients registered with Warwickshire, Derbyshire and Staffordshire FPCs. Random samples, based on computer-generated random numbers, of 100 patient identities were separately and simultaneously drawn from the practice MREs, the practice ASRs and the FPC medical registers. This process generated 300 patient identities per practice. On identifying a patient from, for example, an age-sex card, the name, address, sex and date of birth were entered on a recording form. The corresponding details as found in the same patient's MRE and FPC register were then entered on the form. The patient was sent a form by post and asked to answer questions on the same personal details. A postal reminder was sent to non-respondents after a period of three weeks, and those who failed to reply to both postal enquiries were visited at home. This procedure gave a grand total of 1,500 patients.

Statistical methods

The combination of the three samples presented some statistical problems. This led us to use a correction procedure (described in the statistical appendix) in the analyses presented below.

Results

The random samples drawn from the three registers were comparable with the age-sex profile in the total aggregated population of the three age-sex registers. It is reasonable to assume, therefore, that these sample results are an accurate reflection of the register status of the whole population from which the samples were drawn.

Figure 1 shows how patients responded to the postal questionnaire. A home visit differentiated between those patients who had merely failed to respond to the first letter and reminder (1·6 per cent), and those who had moved elsewhere and were untraceable (8·7 per cent: practice range 5-13·7 per cent). The overall response was 91·3 per cent. Once traced, no patient refused to fill in their form.

The response rate to the first letter (80 per cent with no refusals) was similar to that achieved by Warren (1976) (81·5 per cent with six refusals). Warren sent no

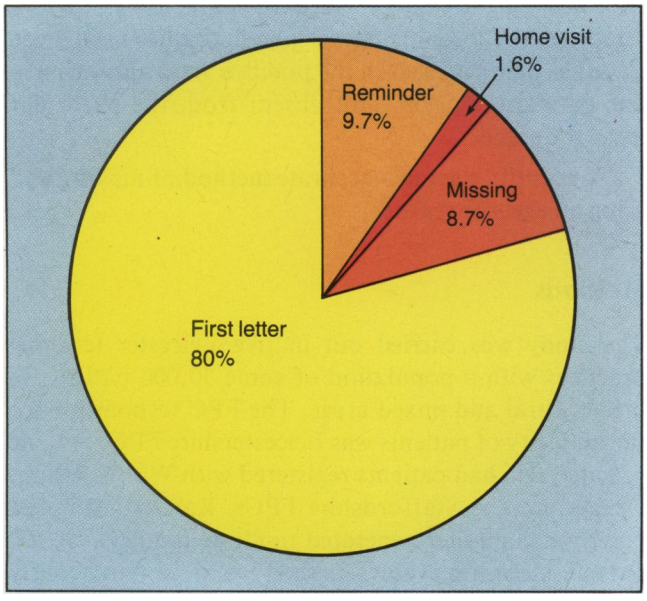

Figure 1. *Patient response (n = 1,500).*

reminders and did no follow-up visit to his non-respondents (5 per cent)—13·5 per cent were known to have moved—but these additional procedures added 9·7 and 1·6 per cent respectively to the response rate in the present study and contributed greatly to the overall response rate achieved (91·3 per cent); Heward and Clayton (1980) also increased their response rate from 82 to 94 per cent by sending a reminder letter.

Tables 1 to 4 indicate the comparative file accuracy for patients' names, sex, age and address. All the findings of the present study relate to patients who were present in the registers and were actually traced, unless otherwise stated. The information supplied by the patient was regarded as 'correct' and any differences from it in the registers were held to be in error within the following definitions:

1. Any one correct forename was acceptable, providing date of birth and sex were correct.

2. Wrong house numbers were ignored, provided the correct street was recorded.

The results in Tables 1 to 3 show an overall high level of accuracy, higher than those generally recorded in previous studies.

Table 4 shows that MREs are the most accurate record of patients' addresses. Other published work (references, Table 5) confirms that the MRE is the most accurate source of a patient's address.

Table 6 demonstrates the degree to which combinations of patient presence or absence in the three registers can predict their actual presence as *bona fide* practice patients. The following important associations are readily apparent:

1. If a patient's name is present in the ASR, the practice holds the MRE and (s)he is registered with the FPC (+ + +), there is a 95·3 per cent chance (range 91·4-97·8 per cent) that (s)he is present and traceable, i.e. is a *bona fide* practice patient.

2. Patients who are not represented in the ASR but are present in the MRE and FPC (— + +) have a 91·3 per cent chance (range 85·7—100 per cent) of being a *bona fide* practice patient.

With all other combinations of register presence or

Table 1. Comparative file accuracy: names.

Study	N	Register	Missing or not matching (per cent)		
			Forename	Surname	Forename + surname
Present	1,349	ASR	*0.2*	*0.5*	*0.6*
Present	1,369	MRE	*0.3*	*0.3*	*0.6*
Present	1,353	FPC	*0.2*	*0.7*	*0.8*
Farmer *et al.* (1974)	593	FPC/MRE	*1.1*	*1.6*	*2.7*

Table 2. Comparative file accuracy: sex.

Study	Register	N	Missing or not matching (per cent)	Criterion
Present	ASR	1,349	*1.3*	ASR v patient
Present	MRE	1,369	*1.4*	MRE v patient
Present	FPC	1,353	*1.3*	FPC v patient
Farmer *et al.* (1974)	MRE/FPC	593	*1.6*	FPC v MRE. No check with patient

Table 3. Comparative file accuracy: age.

Study	Register	N	Missing or not matching (per cent)		Criterion
			Date of birth	Year of birth	
Present	ASR	1,349	*6.0*	*4.5*	ASR v patient
Present	MRE	1,369	*5.8*	*4.2*	MRE v patient
Present	FPC	1,353	*6.7*	*3.9*	FPC v patient
Warren (1976)	FPC/ASR	9,300	*4.4*	—	Updated register comparison
Farmer *et al.* (1974)	FPC/MRE	593	*7.5*	—	Register comparison
Dawes (1972)	MRE	1,628	—	*9.4*	Presence of date of birth or statement of age in MRE

Table 4. Accuracy of addresses in patients traced.

Register	Patients traced	Incorrect address (per cent)	Practice range (per cent)
ASR	1,349 *(100%)*	*8.2*	*3.0-13.3*
MRE	1,369 *(100%)*	*3.9*	*0.7- 8.8*
FPC	1,353 *(100%)*	*17.1*	*8.2-30*

Table 5. Review of comparative file accuracy of addresses.

Author	Source of sample	N	Incorrect address ±patient absent at file-listed address (per cent)	Criterion
Forbes (1969)	ASR	264	*12.1*	Patients > 65
Heward & Clayton (1980)	ASR	2,386	*13.9*	Patients < 5
Warren (1976)	ASR	3,287	*13.5-18.5*	*13.5* per cent returned by post, *5* per cent no reply
Present study	ASR	1,469	*16.0*	—
Hannay (1977)	ASR	3,414	*46.0*	ASR computer file
Heward & Clayton (1980)	HV* record	2,384	*10.8*	Patients < 5
Dawes (1972)	MRE	432	*12.5*	Returned by post
Present study	MRE	1,486	*11.6*	—
Heward & Clayton (1980)	IV** file	2,333	*12.0*	Patients < 5
Farmer *et al.* (1974)	FPC	89	*15.9*	Checked against MRE, not patient
Farmer *et al.* (1974)	FPC	668	*16.9*	
Present study	FPC	1,425	*21.7*	—
Richardson *et al.* (1968)	FPC	600	*30.0*	Checked against MRE, not patient
Gilmore & Caird (1972)	FPC	354	*31.0*	Patients > 65

*Health visitor.
**AHA immunization and vaccination register.

Table 6. Accuracy of registers for tracing patients.*

Register presence/absence				Patients			
				Traced		Untraced	
ASR	MRE	FPC	Sample size	Number	Per cent	Number	Per cent
+	+	+	1,397	1,331	*95.3*	66	*4.7*
+	+	—	61	17	*27.9*	44	*72.1*
+	—	+	2	1	*50.0*	1	*50.0*
+	—	—	9	0	*0.0*	9	*100.0*
—	+	+	23	21	*91.3*	2	*8.7*
—	+	—	5	0	*0.0*	5	*100.0*
—	—	+	3	0	*0.0*	3	*100.0*
Totals			1,500 *(100%)*	1,370	*91.3*	130	*8.7*

*Practice rates + + +: *95.8* per cent, *94.6* per cent, *96.8* per cent, *97.8* per cent, *91.4* per cent.

absence, it is most unlikely that the patient will be traceable as a *bona fide* practice patient:

1. If present in the ASR and MRE but not registered with the FPC (+ + —), there is only a 32 per cent chance of the patient being present.

2. If present in only one register and absent in the other two, there is a zero chance of being a *bona fide* practice patient.

From the figures presented in Table 6 it is possible to calculate the comparative inflation, deflation and aggregate inflation plus deflation rates of the three registers (see Table 7). An explanation of the statistical method used is given in the appendix. Overall, the FPC has the smallest inflation rate (less than half that of the other two registers) with the ASR marginally worse than the MRE. Overall, the MRE has a negligible deflation rate; the other two registers have very small rates with the ASR marginally worse than the FPC. For the overall aggregate inflation plus deflation rates, the FPC is twice as accurate as the ASR.

There were, however, considerable variations between the five practices in constituent values of particular registers, although the general trend confirms the FPC as the most accurate register, followed by the MRE, with the ASR the least accurate.

Characteristics of the missing patients

Sex

Of the 130 untraceable patients, 60 (46·9 per cent) were males and 70 (53·1 per cent) were females. The distribution in the overall sample of 1,500 was 748 males (49·9 per cent) and 752 females (50·1 per cent). These differences are not statistically significant.

Age (Table 8)

Over-represented in the untraceable group were the under one, 21-30 and 31-40 age groups; most under-represented were the 1-10, 11-20 and 41-50 age groups. The 21-40 age group comprised 50 per cent of the missing patients although they were only 28·9 per cent of the total sample. Statistically all these age differences were highly significant (χ^2_7 $p<0·0005$).

Table 7. Register inflation and deflation rates (per cent).*

Practice	ASR			MRE			FPC		
	I**	D**	I+D	I	D	I+D	I	D	I+D
1	*7.9*	*3.1*	*11.0*	*5.0*	*0.5*	*5.5*	*4.1*	*1.6*	*5.7*
2	*11.5*	*4.9*	*16.4*	*8.4*	*0.0*	*8.4*	*8.1*	*1.6*	*9.7*
3	*6.0*	*3.1*	*9.1*	*5.4*	*0.0*	*5.4*	*3.6*	*2.6*	*6.2*
4	*12.9*	*0.0*	*12.9*	*12.9*	*0.0*	*12.9*	*2.2*	*1.6*	*3.8*
5	*14.3*	*0.0*	*14.3*	*16.8*	*0.0*	*16.8*	*9.5*	*1.7*	*11.2*
All practices	*10.6*	*2.3*	*12.9*	*9.8*	*0.1*	*9.9*	*5.5*	*1.8*	*7.3*

*See Appendix.
**I = inflation, D = deflation.

Table 8. Age group of the missing patients.

Age group (years)	Total sample		Untraceable	
	N	Per cent	N	Per cent
<1	58	*3.9*	9	*6.9*
1-10	207	*13.8*	10	*7.7*
11-20	220	*14.6*	11	*8.4*
21-30	188	*12.5*	32	*24.6*
31-40	245	*16.4*	33	*25.4*
41-50	190	*12.7*	10	*7.7*
51-60	163	*10.9*	11	*8.4*
>60	229	*15.2*	14	*10.8*
Totals	1,500	*100.0*	130	*99.9*

Of the 130 missing patients, 63·3 per cent were totally untraceable, but of the rest it was discovered that 15·3 per cent had registered with another practice, 12·2 per cent had moved outside the practice area, 5·4 per cent had died and 3·8 per cent had left the UK. It is interesting to note that only 72 (55·4 per cent) of the 130 were still registered on behalf of the study practices with the FPC.

Morris (1964) found 49·6 per cent untraceable, 31 per cent registered with another practice and 10·2 per cent who had died; 9·2 per cent of his missing patients were represented by duplicate cards, although none in this category was found in the present study.

Discussion

As a prelude to interpreting the results of this study and assessing to what degree they apply to and compare with other general practice situations and findings, several explanatory statements must be made.

As this was a point prevalent evaluation it cannot allow for legitimate time-lags in updating information in a changing situation, for instance change of surname on marriage or removal or inclusion of ASR cards or MREs as patients leave or register with a practice. It is likely, however, that such apparent errors caused by time-lags would have exerted a small influence, as the fieldwork was carried out rapidly in a matter of weeks.

There are comparability problems in evaluating and interpreting the differences in the reported results of the various studies mentioned and the present study, because different authors have used different criteria in assessing accuracy. Our figures refer always to comparisons between register entries and information supplied by the patient personally. Almost all the previously published work was restricted to inter-register comparability without personal contact with the patient to establish the accuracy of personal details; this would have tended to underscore the error rates.

It is probable that the results of the present study represent an optimum state of affairs because of the special nature of the five practices involved. All are teaching practices, most make regular use of their age-sex register and all had an overhaul of their medical records two years prior to the study. It is likely that some file errors and 'ghost' files or patients would have been discovered as a by-product at that stage. The levels of inaccuracy in practices without these advantages would be likely to be greater, but to an unknown degree.

Another factor to be considered is the recent increase in item of service payments in general practice. As a consequence many more forms requiring details of patient identity and address have had to be completed in practices and submitted to FPCs. This would help practices and FPCs to update and maintain their record systems more accurately. Some support for this hypothesis is suggested by comparing the categories of missing patients described by Morris in 1964 and the present study. There are, however, no reasons why the FPCs involved in this study should be any different from other FPCs in this respect.

Bearing these considerations in mind, we believe that our results can be applied to other practices with age-sex registers.

To be most useful, population registers must have an acceptable standard of reliability and validity. To be reliable the registers must provide accurate information about the patient—in this context, name, sex, date of birth and address. It is not sufficient, however, merely to provide inter-register consistency, because the information, although consistent, may be wrong. To assess the true reliability of population registers in general practice it is therefore essential not only to compare patient details as found in the ASR, MRE and FPC files, but also to contact the patient, who can supply the confirmatory evidence which can then be used as a yardstick of accuracy. This practice was not followed by Boyle (1981).

To be valid the registers must represent what they purport to represent; that is to say, each ASR card, MRE or FPC register entry must actually represent a *bona fide* practice patient. ASR cards, MREs or FPC register entries which are found not to so represent a *bona fide* practice patient constitute the register inflation. Validity of registers will also be affected by the numbers of *bona fide* patients who are not represented on the respective registers; those patients constitute the register deflation. Both inflation and deflation may be quantified as rates to give a comparable measure of inter-register validity.

Our results indicate that there is little problem with any of the population registers with regard to patient names, sex and age (particularly as represented by year of birth, which is usually sufficient). Furthermore, register deflation, which has not been previously quantified to our knowledge, does not seem to be a major issue. We cannot, of course, make any statement concerning 'potential patients' who will not appear on any of the population registers, but who may still be at risk of consulting. We hope to be able to report on this aspect from the results of our longitudinal study.

The major discrepancies lie in the areas of inaccuracy of addresses, population inflation rates coupled with the age groups which influence them, and the differential distribution of errors between registers and practices.

Addresses

An accurate knowledge of a patient's address is necessary to make contact for screening, research and administrative purposes. This will be increasingly important as general practice strives to initiate more anticipatory care. Our results show that nearly all patients respond to postal communications from their general practitioners. This readiness to reply has important and encouraging implications for postal research, although we recommend sending a reminder letter. However, if research

by post is to be successful, general practitioners must ensure that their letters actually reach the patients.

It is evident that there are major inconsistencies with regard to recorded address between the various registers (see Tables 4 and 5). It is also evident that the MRE is the most accurate source for patient addresses, followed by the ASR, with the FPC at a great disadvantage. This is not surprising, as the MRE is the working record.

It is fairly obvious that patients do not inform their doctor every time they change their address. Assuming that practices alter the MRE every time a change of address is notified or discovered, the ASR is altered by the practice staffs in only half the instances, and the FPC appears to be informed by practice or patient in approximately one quarter of instances. Ways must be found to encourage patients to notify the practice when they change their address, and practice policies must be instituted to enable staff to update their records whenever a change of address is notified or discovered.

Furthermore, it may not be essential to record addresses on ASR cards at all. This is a logical recommendation when one considers the principal functions of ASRs; patient addresses are either not required or the MRE would need to be involved in any case. This would also save the practice staff a lot of work, which at present is not being done very well. It may be better to concentrate the efforts of the practice staff in making the MRE the central point of patient identification and location. Indeed, if computerization of age-sex registers increases, as has been suggested (RCGP, 1980), much greater storage capacity for more important items will be made available by omitting addresses.

Comparative register population inflation rates

Our results (see Table 7) indicate that the study population is least accurately represented by the ASRs and MREs, as their overall inflation rates of 10·6 and 9·8 per cent respectively are about twice that of the FPC (5·5 per cent). These inflation rates, which vary greatly between practices (6·0-14·3 per cent), result from the failure of practice staffs to remove the ASR cards or return the MREs to the FPC when the patients they represent leave the practices.

As 55 per cent of the missing patients are still registered with the FPC, it follows that the FPC is made aware of patient removals in only 45 per cent of instances. Assuming that the practices are notified by the FPC of all known removals, they could reduce the inflation rates of their ASRs and MREs to the corresponding level of FPC register inflation rates (2·2-9·5 per cent). This could be achieved simply by having an efficient system of removing ASR cards and returning MREs on receipt of the FPC notifications of removal; such a system has been described (Pinsent, 1968).

As only one FPC was predominantly involved, there is a surprising disparity in individual practice inflation rates between FPC-based registers. The same staff deal with all the FPC registers, in contrast to the different practice staffs. This must presumably relate to inexplicable differences in behaviour between the missing patients of practices 1, 3 and 4 compared to those of 2 and 5.

Age and inflation

It should also be noted that the ages of patients contributing to the inflation rates are distributed disproportionately in a highly significant way, with overrepresentation of the under ones and the 21-40 year olds ($p<0·0005$). In these age groups the already high inflation rates of the ASRs will be made worse.

Implications

"There is a lack of unanimity in defining the population to which the general practitioner is at risk" (Morrell *et al.*, 1970). By using different estimates of his at risk population, Morrell calculated that the measured consultation rates in his practice varied from 4·4 to 5·5 per patient per year. It has also been reported that ASR inflation can exceed 20 per cent (Hannay, 1972), and that "discrepancies of this order can have substantial implications for the assessment of workload statistics, morbidity rates, and the accuracy of health care planning" (Fraser, 1978). Furthermore, the uncertainty of the accuracy of the population at risk can cause problems in interpreting numerical data within a practice, and these problems may be made worse when attempting comparisons between practices (Fraser, 1978).

To what extent would the applied results of this study jeopardize the usefulness of the three registers as accurate representations of total population at risk or as sampling frames?

If used as a total population denominator and making the optimum assumption that population inflation values will be totally offset by population deflation values (see Table 7), the optimum error rates are shown in Table 9. (The rates are calculated by subtracting deflation rates from inflation rates.)

The error rates when using the registers as sampling frames (bearing in mind the inadequacies of the MRE and FPC register in this respect) are shown in Table 10. The rates are the sum of the inflation and deflation rates. With regard to the ASR it would mean that the overall error rate of 12·9 per cent would be comprised of patients who were represented in the ASR but were missing (10·6 per cent), and patients who were *bona fide* practice patients but were not represented in the ASR (2·3 per cent). The individual practices exhibit

Table 9. Optimum register population denominator error rates (per cent).

Register	All practices	Individual practice range
ASR	*8.3*	*2.9-14.3*
MRE	*9.7*	*4.5-16.8*
FPC	*3.7*	*0.6- 7.8*

Table 10. Register error rates as sampling frame (per cent).

Register	All practices	Individual practice range
ASR	12.9	9.1-16.4
MRE	9.9	5.4-16.8
FPC	7.3	3.8-11.2

varied error proportions and this would also be true of age subsets.

In reviewing both Tables 9 and 10, it is readily apparent that some practices and registers have 'acceptable' levels of error, while other practices and registers have totally 'unacceptable' levels which would seriously bias any results based on their use. However, how can an individual practice tell whether its practice ASR has an 'acceptable' or 'unacceptable' level of error? None of the teaching practices taking part in this study could predict the error rates involved.

Recommendations

Based on the evaluation of the evidence we have presented we wish to make the following recommendations for constructing new ASRs, evaluating existing ASRs and using general practice population registers in research activities.

Constructing an ASR

1. Start from the FPC register for the total practice population figures (lowest combined inflation and deflation rate).

2. If the patient's MRE is present, there is an 86-100 per cent chance of him or her being a *bona fide* practice patient.

3. Record in the ASR the name, sex and date of birth of the patient but exclude address. Mark the MRE in some way to indicate entry in the ASR.

4. Remove from patient records' file the MREs which have no corresponding FPC registration. There will be approximately 70 per practice of 2,500, of whom only one or two will be *bona fide* practice patients and they should be registered with the FPC.

5. Carry out a validation test (see below).

6. Institute an efficient system of entering cards in the age-sex register when patients join and removing them when patients leave.

Evaluating new or existing ASRs

1. Identify a two per cent random sample (with a minimum of 100) of patient identities from the ASR. Although it is likely that name, sex and date of birth will be acceptably accurate, it is advisable in the first evaluation to record those along with patient address and compare with the corresponding patient entries in the MRE and FPC register and by contacting the patient personally (see Methods).

2. Compare the results with those reported in the present study with particular reference to the relationship of register presence in all three registers as a predictive value of their likely status as *bona fide* practice patients. For example, if a sample of 200 is drawn from a practice ASR and 12 patients are + ——, + + — or + — +, it can be assumed that almost all are untraceable. If of the 188 who are + + +, six are found to be untraceable, then the ASR inflation = 12 + 6/200 = nine per cent. The practice ASR total will have to be reduced by nine per cent to arrive at a more accurate representation of the population at risk.

3. If your results are satisfactory, future checks are still advisable at intervals, perhaps once a year, or before starting a research project. It would not be necessary, however, to contact the patients on subsequent occasions; the + + + patients who are untraceable could be taken to be 3·2 per cent (6/188). It follows that evaluation procedures need not always involve sampling the entire ASR but may be restricted to particular age-sex sub-sets depending on the nature of prospective studies.

4. If very inaccurate results are obtained (?>10 per cent), a complete cross-register check may be necessary, either of the whole ASR or of age sub-sets. This may be particularly necessary in the 0-1 and 21-40 age groups as the registers are likely to be most inaccurate for these groups. A complete cross-register check is probably advisable if computerization of an ASR is to be undertaken.

Using population registers for research activities

If no validation exercise has been carried out:

1. Use FPC list size for the total practice population denominator as it is more accurate than the ASR.

2. For population denominators for age-sex sub-sets, use the FPC register for 65-74 and 75 and over age groups, although no sex differentiation will be possible.

3. Use health visitor records for the under fives and particularly for children under one year of age (see Heward and Clayton, 1980).

4. You are obliged to use the ASR as the population denominator for other age groups but it will have an unknown degree of accuracy and is likely to be particularly inaccurate for the under ones and the 21-40s.

5. Having drawn a sample for research (or screening) purposes, consult the MRE for the most accurate address.

Conclusions

In general our hypotheses have been confirmed. We are not suggesting, however, that all age-sex registers have a level of inaccuracy which would seriously bias their use as population denominators, sampling frames and so on. The key issue is that, because some ASRs have

unacceptably high levels of inaccuracy, it is important for doctors to be aware that they must find out how reliable and valid their own ASR is and to have at their disposal some relatively convenient and economic method for doing so. We believe that we have determined such a method and have made a case for the need to employ it. If this is not done, British general practitioners with an ASR will be no more fortunate than overseas colleagues who do not have the benefit of registration of patients with an individual NHS doctor. To arrive at an estimate of their at-risk populations, Canadian colleagues, for example, have been forced to extrapolate their population at risk from patient utilization rates or episodes of illness rates (Bass, 1976) and household data files (Newell *et al.*, 1976). The age-sex register is undoubtedly the most versatile and most convenient aid to research and screening in British general practice—but it has to be accurate.

Appendix: Statistical method

The method of sampling used in this study has necessitated a slightly unusual method of analysis. It would be perfectly correct to use only the original 500 samples of the ASR to investigate ASR accuracy and likewise use the 500 samples of the MRE and the FPC register. This is not very efficient, however, and, with regard to the ASR, for example, it is preferable to use all of the 1,469 patients identified as being present in the ASRs irrespective of the original source of the sample.

This procedure is unfortunately not legitimate. To demonstrate the problem it is necessary to consult Table 6, which cross-classifies the sample according to presence or absence on each of the three registers with their status as *bona fide* practice patients. By the nature of the sampling strategy, individuals in the practice populations in the + + + category could have been selected from each of the three registers. Individuals in the + + —, + — + or — + + categories, however, could only have been selected from two of the sources, and individuals in the + — —, — + — and — — + categories could have been selected only from the one register on which they appear. Thus, different individuals have different chances of being selected in the sample and this might distort results.

The solution is simple: when carrying out any analysis on the combined data, it is necessary to give the following weights to different individuals:

Register presence/absence	Weight
+ + +	1/3
+ + — + — + — + +	1/2
+ — — — + — — — +	1

This procedure restores the integrity of the sample, providing the registers are not of grossly different sizes. As this condition was fulfilled in the present study it was legitimate to apply the above adjustments throughout.

As an example of these procedures, consider the calculation of ASR inflation from the data set out in Table 6. Patients on the ASR can be present in four different combinations. With weighting this becomes: (1/3 x 1397) + (1/2 x 61) + (1/2 x 2) + 9 = 506·17. The equivalent (weighted) number of patients untraced is: (1/3 x 66) + (1/2 x 44) + (1/2 x 1) + 9 = 53·50, and the ASR inflation is 53·50÷506·17 = 10·6 per cent.

Finally, a reference to register 'deflation'. It is interesting to speculate on the existence of a ——— cell in Table 6, representing patients not present on any register, yet in a sense present in the practice area and potentially looking to the practice for medical care. Clearly this sampling frame cannot discover such individuals, but if they exist deflation rates will be higher than quoted in this paper. As the underestimate is present for all three registers, their relative accuracy is unaffected.

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Acknowledgements

It is a pleasure to record our thanks to the following, without whose help the study could not have been carried out: the doctors and staffs of the participating practices; the administrators and staffs of the FPCs of Derbyshire, Staffordshire, Warwickshire and, above all, Leicestershire; and Mr Les Abiss, Registrar, Leicestershire FPC, for his enthusiastic support and advice. We record with gratitude that the study was supported by a grant to Dr R. C. Fraser from the Trent Regional Health Authority.

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