should be performed within the health promotion clinics.

This means that in addition to initial health checks 750 patients can be followed up at the health promotion clinics, assuming on average two follow up appointments per patient ($4500 - 3000 \div 2 = 750$). The practice has 1000 patients who are already being treated for coronary heart disease, hypertension, hyperlipidaemia, or diabetes—clinical risk patients. The practice decides that 500 of these could be followed up in the health promotion clinics, leaving 250 places for multiple risk patients ($750 - 500 = 250$).

The practice decides to target men and women aged 40-59 and finds from its records that there are 2000 in this age group. This means that people aged 40-59 who have a Dundee rank of 12.5 or more can be followed up ($250/2000 \times 100 = 12.5$).

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Unemployment rates: an alternative to the Jarman index?

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Abstract

Objective—To compare the Jarman index with alternative deprivation measures with regard to its usefulness to district health authorities as an indicator of need at small area level.

Design—The Jarman index (UPA (8)), Townsend's index of material deprivation, the Scottish Development Department's index, the Department of the Environment's basic index, and unemployment rates were compared in respect of their correlation with measures of morbidity by electoral ward in a typical English district health authority. Measures of morbidity comprised standardised mortality ratios, admission rates (standardised and non-standardised), and permanent sickness rates. Spearman rank correlation coefficients were calculated for each combination of measures and were then ranked for each of the deprivation indices.

Setting—The 59 electoral wards of the Central Nottinghamshire Health Authority.

Results—The Jarman index consistently ranked lower in respect of its correlation with measures of morbidity than did the other deprivation measures. Current unemployment rates correlated well with morbidity measures, in particular with hospital admission rates, with correlations ranging from 0.669 to 0.830 for average and standardised all age admission rates.

Conclusions—The Jarman index seems to be the least appropriate of these indices for health authority use. Unemployment rate merits further consideration as a simple, up to date marker for

deprivation and consequent need for health service provision.

Introduction

The definition and measurement of deprivation is a topical issue. Since the 1960s the extent and also the importance of the association between deprivation and ill health has become increasingly apparent. The magnitude of the differential between population groups in respect of their experience of ill health is considerable.^{1,2} Various indices have been developed to measure deprivation—the choice of which to use is not merely a matter of semantics. Comparison of two of the better known indices showed that different localities were identified by each as being deprived.³ Choosing which of these indices to use merits more attention from those involved in health care planning.

The choice of deprivation index is particularly important to health authorities who must ration scarce resources on the basis of need. The National Health Service and Community Care Act 1990 gives health authorities a specific role in assessing need. As a result of the Department of Health's recent introduction of the Jarman underprivileged area 8 (UPA (8)) score in respect of general practitioner payments, the Jarman index has been much publicised and is readily available; it has begun to be widely used by district health authorities as a measure of deprivation and consequent need. Of 140 annual reports presented to district and regional health authorities by their directors of public health in 1989, 54 made substantive

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reference to the Jarman index; there were only four references to other indices.⁴ These reports are designed to inform the planning and contracting processes of health authorities, and needs assessment is a basic tenet of their existence.

The Jarman index was designed as a method of identifying areas of high workload for general practitioners from routinely available census data. It was not designed for use as a measure of need within localities for either health care services or health promotion input and has not been adequately validated for these purposes. Despite its widespread adoption the Jarman index may not be the best deprivation indicator to use in such a context. Other composite indices and single variable measures may be more appropriate.

The use of the Jarman index by health authorities has begun to attract considerable criticism,^{5,6} but little has been published that directly compares it with the alternatives. Various studies have looked individually at Townsend's index of material deprivation, the Department of the Environment's basic index, the Scottish Development Department's index, and the Jarman index and also at unemployment rates in respect of the extent of their association with mortality and morbidity measures.⁷⁻¹³ Although there is strong evidence for the association of each of these indices individually with different measures of morbidity at electoral ward and district level, little has been published that directly compares them with each other.

The Resource Allocation Working Party (RAWP) review and Carstairs's work in Scotland indirectly compared composite indices by examining their usefulness as component parts of the resource allocation working party formula when combined with the standardised mortality ratio.^{14,15} They did not directly compare the correlation with morbidity. Carstairs modified the Jarman index to exclude the ethnic component and used her own version of the Scottish Development Department's index. Mays and Chin correlated the Townsend and Jarman indices at regional and district level with standardised mortality ratios to look at the validity of the standardised mortality ratio as a morbidity measure in resource allocation but did not compare the indices directly.¹⁶

This study compares the Jarman index with four other measures of deprivation at electoral ward level

within a district health authority. It examines the extent to which each measure correlates with a range of measures of morbidity.

Methods

The study used data based on the resident population of electoral wards of an English district health authority situated in the east midlands with a population of just under 300 000 living in mixed urban and rural areas. There is a mix of light industry, mining, and agricultural communities and commuter belt villages for England's eighth largest city. The demographic structure is similar to that of the United Kingdom as a whole. Overall unemployment is similar to the national average. The Jarman score of -11.65 is within one standard deviation of the national mean. The standardised mortality ratio in 1989 for the district as a whole was 100 (95% confidence interval 98 to 102). Hospital services are mainly district general hospitals with ready access to nearby teaching centres. The data used were resident based, covering admissions within and outside of the district itself. The population of the district as a whole has increased by only 2.1% between the 1981 census and the mid-1989 estimate of the Office of Population Censuses and Surveys. Over the same period the total population of 36 of 59 electoral wards changed by less than 5%; in 57 wards it changed by less than 10%. There are no obviously unusual features in this district that might render the study's results inapplicable elsewhere.

Morbidity measures were calculated for each of the electoral wards. In calculating standardised mortality ratios, mortality data aggregated over the years 1981-9 for each ward were used to give an observed number of deaths. Nine year aggregate data were used because of the problem of interpreting small numbers in some of the wards. Expected numbers of deaths were calculated by applying mortality rates specific for age, sex, and year to the England and Wales population of each ward at the 1981 census. Age was grouped in five year bands. The standardised mortality ratio for those aged under 65 was calculated by the same indirect method but excluded death in those aged 65 and over. The 1981 census is the only routinely available source of population data by age band at ward level.

For the years 1983-5 average admission rates by electoral ward were calculated from Hospital Activity Analysis deaths and discharge data for all residents of the district health authority for treatment within and outside the district. Standardised hospital admission ratios quoted for the years 1983-5 were calculated from the same data by the indirect method of standardisation. The method was analogous to that used in calculating the standardised mortality ratios by electoral ward except that the expected admissions were calculated using 1984 rates.

Age specific ratios were calculated separately for each ward for age groups 0-14 years and over 75 years. The data on 1989-90 hospital admissions were from the Trent patient information system for all district residents and included admission within and outside the district. Ward rates were calculated using the county council's mid-1989 estimates of ward population.¹⁷

The permanent sickness rate was the percentage of the population so categorised in the 1981 census.

The four deprivation indices used were the Jarman underprivileged area 8 score,¹⁸ Townsend's index of material deprivation,¹⁹ the Scottish Development Department's index,²⁰ and the Department of Environment's basic index.²¹ Table I shows component variables and weightings given in each index. Descriptions of their calculation are available elsewhere and have not been included.

TABLE 1—Weightings of component variables of deprivation indices

Census variable*	Townsend's material deprivation index	Scottish Development Department's index	Department of the Environment's basic index	Jarman index
Unemployment	1	1	2	3.34
Overcrowding	1	1	1	2.88
No car	1	1		
Non-owner occupation	1			
Social class		1		
Unskilled				3.74
Pensioners alone			1	6.62
Single parent			1	3.01
No amenities			1	
Ethnicity			1	2.50
Children under 5				4.64
Moved within year				2.68

*Description of census variables (precise definition of each variable may differ between indices):
 Unemployment=percentage of economically active residents who are unemployed (Jarman included the temporarily sick).
 Overcrowding=percentage of residents living in households of more than one person per room.
 No car=percentage of households without access to a car.
 Non-owner occupation=percentage of homes that are not owner occupied.
 Social class=percentage of people in households headed by a person in social classes IV & V.
 Unskilled=percentage of people in households headed by a person in socioeconomic group 11.
 Pensioners alone=pensioners as a proportion of all residents in private households.
 Single parent=people in households of one person over 16 and one or more children under 16 as a proportion of all residents in private households.
 No amenities=percentage of private households lacking the exclusive use of a bath and inside toilet.
 Ethnicity=people in households headed by a person born in the New Commonwealth or Pakistan as a proportion of all residents in private households.
 Children under 5=children under 5 as a proportion of all residents in private households.
 Moved within year=people aged 1 or over with a usual address one year before the census different from present usual address.

Percentage unemployment rates based on Department of Employment statistics were obtained from the county council by electoral ward.²² These were not available at ward level before December 1985 so the 1985 rate is based on that month. The 1989-90 rate is the average monthly rate over the year December 1989 to December 1990. Unemployment figures for 1981 had to be taken from the census. These are the same figures as used in the Townsend score—that is, they exclude temporarily sick people.

Spearman rank correlation coefficients²³ were calculated for each deprivation measure with each health measure. The coefficient obtained was adjusted for tied ranks and each result was tested for statistical significance. Correlation coefficients obtained were then ranked as a measure of the relative merits of each deprivation measure. Spearman rank correlation coefficients were used in preference to Pearson product moment correlation coefficients because the parametric assumptions of the Pearson coefficient may have been invalidated by the distributions of several of the indices under investigation.

Results

Table II sets out the mean, standard deviation, and range of the distribution across the 59 electoral wards for each indicator of deprivation and morbidity. The unemployment rate for 1985 was appreciably higher than in either of the other years studied. Admission rates in 1990 were higher than in 1985, though differences between data sources limit direct comparability. For the standardised mortality ratios and the standardised and the age specific admission ratios, using ratios of ward rates to the rates for England and Wales allows comparison with the national rates, though for the age specific ratios it has to be remembered that the data have not been standardised for age and sex.

TABLE II—Measures of deprivation and morbidity for one district health authority (59 electoral wards)

	Mean	Standard deviation	Range
Deprivation index:			
Jarman	-3.4	12.5	-25.3-29.0
Townsend	-0.6	2.6	-5.4- 6.5
Scottish Development Department	-0.5	1.9	-3.8- 4.7
Department of the Environment	-0.4	3.3	-5.8-10.5
Unemployment rate:			
1981	6.5	2.3	2.5-14.0
1985	11.6	4.1	5.5-24.4
1990	6.4	2.8	2.5-16.0
Standardised mortality ratio*:			
All ages	105.8	13.0	69-137.8
Age under 65	97.2	17.1	62.4-138.8
Admission rates:			
Average 1983-5†	101.8	17.1	59.4-142.4
Standardised 1983-5*	99.9	16.7	58.1-139.5
0-14 years*	75.4	21.7	35.3-130.7
Over 75 years*	110.9	21.7	58.8-158.2
Average 1989-90†	163.5	33.8	91.5-236.8
Permanent sickness rate‡	1.9	0.8	0.6-4.4

*Ward rates as a percentage of rates for England and Wales.
†Per 1000 population.
‡1981 Census.

Table III shows the Spearman rank correlation coefficients for the associations found between deprivation and health measures. With the exception of the correlation of Jarman index and standardised mortality ratio, each deprivation measure correlates significantly ($p<0.05$) with all of the morbidity measures. The deprivation indices were ranked in order of their correlation with each morbidity measure. The Jarman index ranked seventh in its correlation with all but one of the measures of morbidity used, ranking sixth in its correlation with admissions for those over 75 years old. Current unemployment rates correlated strongly with hospital admission rates and ranked first except for admissions over 75.

Discussion

The use of the Jarman index by health authorities for assessing needs can be criticised in two main respects. The first arises from the fact that, unlike the other indices, the Jarman index was not originally constructed to be used as a measure of deprivation. The score was created from general practitioners' subjective impressions of social factors in their patients that adversely affected their workload. General practitioners may have weighted categories of patients simply because their very difference made them stand out, rather than from any objective information that they contribute unduly to their workload. If the purpose of applying the Jarman index to the payment of general practitioners is solely to attract or reward those working in areas perceived, rather than objectively measured, as having higher workloads then its use in that context (leaving aside details of the payment structure) may well be appropriate. If the intention is to use it otherwise, it is not appropriate. Secondly, the score can be criticised on the detail of its construction, as has been done extensively elsewhere.^{24 25} In particular, attempts to normalise the distribution of component variables, most notably ethnicity, did not completely succeed. That is, some of the distributions remain skewed despite the arc sin transformation. The use of the z score technique of standardisation to produce a composite score²¹ can be inappropriate when applied to variables distributed non-normally because high scores on skewed variables can add a hidden weighting to the index over and above that originally intended by the general practitioners consulted.²⁴

Although they utilise similar techniques of construction, the other deprivation indices suffer less from difficulties with very skewed variables. Townsend's index of material deprivation is constructed from variables representing absence of material resources: not owning the home, unemployment, lack of access to a car, and overcrowding. The Scottish Development Department's index is similar to Townsend's index but substitutes social class for housing tenure. The Department of Environment's basic index is composed

TABLE III—Correlation of measures of morbidity and deprivation in 59 electoral wards. Figures in brackets are rank orders of deprivation indices by extent of correlation

Morbidity measure	Deprivation measure						
	Jarman index	Townsend index	Scottish Development Department's index	Department of the Environment's basic index	Unemployment rate		
					1981	1985	1990
Standardised mortality ratio:							
All ages	0.212 (7)	0.478 (1)	0.432 (2)	0.294 (4=)	0.286 (6)	0.294 (4=)	0.320 (3)
Age under 65	0.505 (7)	0.661 (1)	0.650 (2)	0.579 (3)	0.549 (4)	0.527 (5)	0.522 (6)
Admission rates:							
Average 1983-5	0.676 (7)	0.735 (5)	0.753 (2)	0.739 (4)	0.717 (6)	0.741 (3)	0.779 (1)
Standardised 1983-5	0.549 (7)	0.755 (2)	0.742 (3)	0.648 (6)	0.669 (4=)	0.669 (4=)	0.760 (1)
0-14 years	0.494 (7)	0.614 (4)	0.650 (2)	0.539 (6)	0.574 (5)	0.629 (3)	0.769 (1)
Over 75 years	0.416 (6)	0.467 (2)	0.455 (3)	0.358 (7)	0.470 (1)	0.438 (5)	0.451 (4)
Average 1989-90	0.653 (7)	0.763 (3)	0.773 (2)	0.695 (5)	0.693 (6)	0.742 (4)	0.830 (1)
Permanent sickness rate	0.557 (7)	0.759 (2)	0.760 (1)	0.587 (6)	0.625 (4)	0.616 (5)	0.725 (3)

Spearman rank correlation coefficient $>0.26=p<0.05$; coefficient $>0.33=p<0.01$.

of six social variables from the census, transformed and combined, and is the index most closely resembling Jarman's index.

Composite scores have been criticised by Thunhurst as "throwing everything into a statistical melting pot and expecting to produce 'an answer.'"²⁴ The impetus to use this approach has been the belief that the more variables used, the more representative the score will be of the multidimensional nature of deprivation and the more stable the index will be over time (or between censuses).¹⁴ The transformation and addition necessary to combine variables may, however, distort the original representation, and the index may well end up not representing what was intended. By contrast, percentage unemployment is a single variable that does not need standardisation and weighting before it can be used as a measure.

Changing levels of car ownership and housing tenure may also be problematic for the composite indices. As has become true for not owning a television, for some people not owning a car may be by choice; not because of deprivation. Any change in social meaning of such factors will, of course, influence what the composite scores are indexing. The utility of such indices in the future is therefore questionable. These considerations would support the use of a measure such as unemployment rate, which is likely to have a stable relation with deprivation, at least for the foreseeable future.

UNEMPLOYMENT AS A MEASURE OF DEPRIVATION

Brenner describes the unemployment rate as "reflecting loss of income, social status, and close personal attachments for individuals and entire families."¹¹ In our study the correlation between unemployment as measured in the 1981 census and the composite deprivation indices was very high, with Spearman rank correlation coefficients of 0.799 for the Jarman index, 0.874 for Townsend's index of material deprivation, 0.902 for the Scottish Development Department's index, and 0.904 for the Department of the Environment's basic index. We suggest that the unemployment rate in the community is acting as a marker of both material and social deprivation, not just among the unemployed but for the community as a whole. It would seem to be as good a proxy measure for deprivation as are the composite indices. Unlike the composite indices, which cannot be updated other than after the census—every 10 years—unemployment figures can be updated monthly and they are now available at ward level. The Department of Employment makes available every month the numbers of people claiming unemployment benefit by electoral ward. Although these data are collated using the full postcode, electoral wards are the smallest geographical area for which this information is produced. This provides the numerator for the construction of unemployment rates.

The Department of Employment constructs rates only for areas known as travel to work areas. There are 322 of these nationally, and they are aggregates of electoral wards. The rates are produced only at this level because the denominator used by the department is updated annually from the labour force survey, the sample size of which limits extrapolation to smaller areas.

Other estimates of the working population can be used as a denominator to produce rates at electoral ward level, the basic building block being the resident population between 15 and 64 years of age, with adjustments for students and the self employed. The ward rates we used are routinely produced this way by the county council. Care has to be taken when comparing electoral wards in different parts of the country that the denominators used are the same.

DEPRIVATION AND MEASURES OF MORBIDITY

No ideal measure of morbidity is generally available. All of the measures of ill health which we included—standardised mortality ratios, hospital admission rates, and permanent sickness rates—use routinely available data to which all health authorities have access. The measures approach the issue of ill health from three broadly different perspectives.

Standardised mortality ratios are well recognised as a proxy for morbidity. Although they have limitations, the Resource Allocation Working Party review considered their continued use in resource allocation to be justified.¹⁴ Deaths of people aged under 65 are often seen as premature and potentially avoidable; the under 65 standardised mortality ratio is generally considered to be an indicator of avoidable mortality.

Hospital admission rates are direct measures of morbidity. Their limitations are that they provide information only on illness requiring treatment as a hospital inpatient and that the availability of services, access, and expectations influences admission to hospital. Data on hospital admissions are subject to geographical variation, reflecting the supply or availability of hospital beds and services, but this criticism is largely obviated within a single district served mainly by one district general hospital. Carstairs commented on this, pointing out the decreased relevance of this as an issue at small area level, where access is often to the same level of beds.¹⁵

In using the age standardised admission rates (1985 was used being closer to the census population measurement) it was, of course, recognised that to compare an age adjusted index of morbidity to an age dependent index of deprivation, such as Jarman's, may be somewhat inappropriate. Thus some of the variability of the Jarman index across wards may be a consequence of differing age structures; the correlation between the Jarman index and admission rates will therefore be blunted if the equivalent age dependent component of the variability of the admission rate is removed. None the less we investigated the effect of age standardisation to determine whether the individual indices (Jarman included) correlated with the component of morbidity that is unrelated to age structure. Because of the broadly similar age structure of electoral wards in the district the age standardisation had little impact on the relative admission rates in the different wards and thus had little influence on the results of the study. The correlation between crude and standardised admission rates was high (Spearman rank correlation coefficient = 0.92).

The age specific admission ratios (0-14 years and over 75 years) were included to see if hospital admissions in these age groups were any more or less associated with deprivation than were admissions generally. It is interesting to note that the extent of the association between deprivation and hospital admissions in the under 15 age group tended to be slightly stronger than that in the over 75 age group. Hart notes the systematic association between death rates and class at every age, which is most pronounced in the younger years and diminishing with age.²⁶ This view is challenged by West, who sees the situation as more complex, with the class differentials evident in early childhood all but vanishing in adolescence only to reappear relatively soon thereafter.²⁷

Hospital admissions correlate highly with all the measures of deprivation. These findings reflect those of the Resource Allocation Working Party review, which found variations in use of services to be associated with variations in social deprivation measures.¹⁴

Permanent sickness rates, though subjective, are the only routinely available comprehensive measure of chronic ill health in the community. This has implications for health service resources which are not

necessarily reflected in the death rate or hospital admission data. The association between permanent sickness and deprivation provides an important and different perspective. The deprivation measure which set out to reflect general practitioners' workload, the Jarman index, might be expected to correlate better with this morbidity measure than would the other indices. It does not do so.

COMPOSITE INDICES, UNEMPLOYMENT, AND MORBIDITY

Comparing the composite indices, with the exception of the Jarman index related to the standardised mortality ratio, each measure of deprivation correlates significantly with each measure of morbidity. The Jarman index correlates less well than do the alternatives, especially Townsend's index and that of the Scottish Development Department. Carstairs, in Scotland, in one of the few direct comparisons of deprivation indices, similarly found that the Townsend index and the Scottish Development Department's index produced stronger correlations with standardised mortality ratios and permanent sickness than did the Jarman index.²⁸ The Jarman index, however, correlated marginally better with hospital use, largely of the lone elderly. Comparisons between Carstairs's results and the results of this study are limited by her exclusion of the ethnic component from the Jarman index used in Scotland and by the different social meaning of housing tenure north and south of the border.

In our district health authority the Jarman index ranked seventh in its correlation with seven of the eight morbidity measures used and sixth in its correlation with the eighth. In view of the strong correlation between the individual morbidity measures, the eight correlation coefficients relating the Jarman index to each of the morbidity measures should not be considered independent of one another. Each correlation coefficient does not represent a completely separate item of evidence against the utility of the Jarman index in this context. It would be difficult though, given these results, for this health authority to justify the use of the Jarman index in preference to the alternatives. There is no reason to suppose these results to be any less applicable elsewhere.

Current unemployment rates compare well with the composite indices in respect of their association with hospital admissions. In particular, the correlation between 1990 unemployment rates and 1990 hospital admission rates is strong (0.830); the equivalent 1985 coefficient is slightly lower (0.741). Although unemployment rates have been determined at different points of time in this study, changes in the method of calculation over the period limit the validity of direct comparison. Definitions of unemployment vary. The measure used here for the years 1985 and 1990 is that of the Department of Employment: this is the claimant count and measures the number of people who are eligible for and are claiming unemployment benefit. Changes in rules concerning eligibility for benefit are likely to alter the nature of the population defined as unemployed, making comparisons over time difficult. This is different from the International Labour Organisation's definition, which is of people without paid jobs who were available to start work in the next two weeks and had actively sought work at some point during the previous four weeks. This definition includes all those looking for work, whether or not they are eligible for and claiming benefit, and is the definition used in the annual labour force survey. Comparison of the two definitions of unemployment at the time of the labour force survey showed broadly similar trends from 1984 to 1988, after which they diverge, the claimant count falling more rapidly.²⁹ Changes in levels of unemployment

may also affect the nature of the population unemployed.³⁰

Associations between unemployment and ill health have been shown elsewhere. Mortality from all causes¹¹ and from ischaemic heart disease,¹² in particular, have been linked to unemployment. A study by Yuen and Balarajan of 13 000 people showed that general practice consultation rates were also associated with unemployment.³¹ The Office of Population Censuses and Surveys' longitudinal study found that mortality among unemployed men was higher than among employed men and concluded that this occurred for reasons other than initial poor health.³² Mays and Chin showed a strong correlation at district level between the standardised mortality ratio and the Jarman and Townsend indices and also some of their component variables when the inner London districts were excluded from the analysis.¹⁶ The relation between these indices and the standardised mortality ratio was demonstrably different in inner London than in the other districts for all variables "with the sole exception of unemployment." Unemployment seems from their study to be the one deprivation measure that might apply equally well to inner London as to other districts.

Some of the problems in the use of the Jarman index in a general practice payment context have already been discussed. If the intention behind using the Jarman index is to provide incentives for general practitioners to work in areas perceived to be of heavier workload then our study sheds no further light on the validity of that use. If the Jarman index is intended to be used as an objective measure of actual workload then measures such as consultation rates and case mix presenting to general practitioners might be more appropriate measures for comparison. The measures examined in our study are indirect and unsatisfactory for this purpose. If, though, the intention behind the use of a deprivation measure in general practice extends, as might be more appropriate, to informing comparisons made between needs of different populations for primary health care and the potential workload these needs should generate then the results of this study may well raise questions as to whether the Jarman index is the one most appropriate for use in such a context.

The objective of our study was to compare the Jarman index with alternative measures as an indicator of need at small area level for use by a district health authority. Our results challenge the increasing adoption of the Jarman index as the appropriate deprivation measure for use in allocating resources by health authorities, particularly community based resources.

Health authorities have a remit to identify need for health care. Deprivation measures contribute to the assessment of need in a manner that is independent of health care provision. They do so by identifying communities where health care need is greater; communities where material resources are less and consequently the capacity to cope with the consequences of illness is less; and communities in which ill health is likely to be greater in the future. Deprivation has implications for both the provision of health care services and input on health promotion and disease prevention. Whether they are complex indices or single variables, deprivation measures should be judged on their capacity to predict communities requiring increased health service input and to do so as early as possible in the cycle of deprivation and ill health. Because it correlates well with ill health measures and is available on a monthly basis rather than once every ten years, the unemployment rate deserves further consideration as a measure of deprivation by all those involved in health care planning.

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Risk factors for developing non-insulin dependent diabetes: a 10 year follow up of men in Uppsala

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Abstract

Objective—To analyse anthropometric and metabolic characteristics as risk factors for development of non-insulin dependent diabetes mellitus in middle aged normoglycaemic men.

Design—Prospective population study based on data collected in a health survey and follow up 10 years later.

Setting—Uppsala, a middle sized city in Sweden.

Subjects—2322 men aged 47-53, of whom 1860 attended the follow up 7-14 years later, at which time they were aged 56-64.

Main outcome measures—Incidence of non-insulin dependent diabetes.

Results—In a multivariate logistic regression analysis, variations of 1 SD from the mean of the group that remained euglycaemic were used to calculate odds ratios and 95% confidence intervals. Blood glucose concentration 60 minutes after the start of an intravenous glucose tolerance test (odds ratio=5.93, 95% confidence interval 3.05 to 11.5), fasting serum insulin concentration (2.12, 1.54 to 2.93), acute insulin increment at an intravenous glucose tolerance test (1.71, 1.21 to 2.43), body mass index (1.41, 1.01 to 1.97), and systolic blood pressure (1.23, 0.97 to 1.56) were independent predictors of diabetes. In addition, the use of antihypertensive drugs at follow up (selective or unselective β blocking agents, thiazides, or hydralazine) was an independent risk factor (1.70, 1.11 to 2.60).

Conclusions—Metabolic and anthropometric characteristics associated with or reflecting insulin resistance as well as a poor acute insulin response to glucose challenge were important predictors of future diabetes in middle aged men. Antihypertensive

drugs were found to constitute a further, iatrogenic risk factor.

Introduction

That obesity is one of the predisposing factors for non-insulin dependent diabetes mellitus has been shown in several prospective population studies.¹⁻⁵ Hereditary factors as expressed by a history of diabetes in close relatives also seem to be important.⁶⁻⁹

During the past decade criteria for impaired glucose tolerance and non-insulin dependent diabetes have been set using the oral glucose tolerance test. In the early 1970s the intravenous glucose tolerance test seemed a likely tool for diagnosing diabetes, but no criteria for using it to diagnose non-insulin dependent diabetes have been proposed.

A low insulin concentration soon after glucose injection is found in normoglycaemic relatives of patients with non-insulin dependent diabetes and also in patients with impaired glucose tolerance or non-insulin dependent diabetes.^{10,11} It has been suggested that people with a low early insulin response are at risk of developing non-insulin dependent diabetes,¹² but this has not been confirmed in prospective studies. Impaired insulin action (insulin resistance) is a precursor of non-insulin dependent diabetes in Pima Indians and Mexican-Americans¹³⁻¹⁶ and white European women.¹⁷

During 1970-3 the intravenous glucose tolerance test was used in a large population based survey in Uppsala, Sweden, to characterise glucose metabolism in middle aged men. The present study aims to investigate the incidence of non-insulin dependent diabetes during an observation period of about 10 years in these men and

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