Cohort study of multiple brain lesions in sport divers: role of a patent foramen ovale

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Abstract

Objective: To investigate the role of a patent foramen ovale in the pathogenesis of multiple brain lesions acquired by sport divers in the absence of reported decompression symptoms.
Design: Prospective double blind cohort study.
Setting: Diving clubs around Heidelberg and departments of neuroradiology and neurology.
Subjects: 87 sport divers with a minimum of 160 scuba dives (dives with self contained underwater breathing apparatus).
Main outcome measures: Presence of multiple brain lesions visualised by cranial magnetic resonance imaging and presence and size of patent foramen ovale as documented by echocontrast transcranial Doppler ultrasonography.
Results: 25 subjects were found to have a right-to-left shunt, 13 with a patent foramen ovale of high haemodynamic relevance. A total of 41 brain lesions were detected in 11 divers. There were seven brain lesions in seven divers without a right-to-left shunt and 34 lesions in four divers with a right-to-left shunt. Multiple brain lesions occurred exclusively in three divers with a large patent foramen ovale ($P = 0.004$).
Conclusions: Multiple brain lesions in sport divers were associated with presence of a large patent foramen ovale. This association suggests paradoxical gas embolism as the pathological mechanism. A patent foramen ovale of high haemodynamic relevance seems to be an important risk factor for developing multiple brain lesions in sport divers.

Introduction

Scuba diving (diving with self contained underwater breathing apparatus) has become a popular sport. There are about three million certified sport divers in the United States and about one million in Europe. While neuroimaging studies exist for professional divers,[1,2] divers with decompression accidents,[3] and compressed air tunnel workers,[4] it was only recently that a larger population of sport divers, most of whom never had a decompression accident, was investigated by magnetic resonance imaging.

Reul *et al* found an increased prevalence of brain lesions in sport divers compared with non-diving controls.[5] However, about 80% of all brain lesions were found in a subgroup of 27% of the divers. Whereas single lesions in the white matter of the brain were common and were also seen in 20% of the controls, multiple brain lesions (more than four) were detected exclusively in divers. While the authors stated that the brain lesions in divers were probably due to arterial gas embolism during or after surfacing, they did not address the question of how the gas emboli entered the arterial circulation.

Gas bubbles are known to be present in venous blood after ascents from water depths as shallow as three metres.[6] However, the lungs usually constitute a competent filter for these bubbles,[7] and they do not normally enter arterial circulation. A patent foramen ovale or other right-to-left shunt as a pathway for the arterialisation of venous bubbles is present in about 10-30% of the general population.[8-11] This prevalence roughly equals the percentage of divers with multiple brain lesions in the study of Reul *et al*. This led to the hypothesis, most recently expressed by Wilmshurst *et al*,[12] that divers with a patent foramen ovale might have a high risk of developing brain lesions.

Whereas the prevalence of patent foramen ovale has been found to be increased in divers with decompression sickness,[13,14] especially in cases of early onset decompression sickness with neurological symptoms (type 2 decompression sickness),[14] no study has addressed the question of whether divers with a patent foramen ovale are prone to developing multiple brain lesions in the absence of decompression sickness. This is important for estimating individual risk in sport diving, and we therefore conducted the present study to answer this question.

Methods

Subjects

We informed adjacent diving clubs about our study and asked for volunteers, with the proviso that subjects must have made a minimum of 160 scuba dives. We subsequently enrolled 100 sport divers, although nine failed to attend. We obtained a medical history to identify and exclude divers with diseases known to potentially cause cerebral lesions, such as multiple sclerosis or cerebrovascular disease. Four divers had to be excluded: two had a history of cerebral stroke, one

See editorial by Wilmshurst

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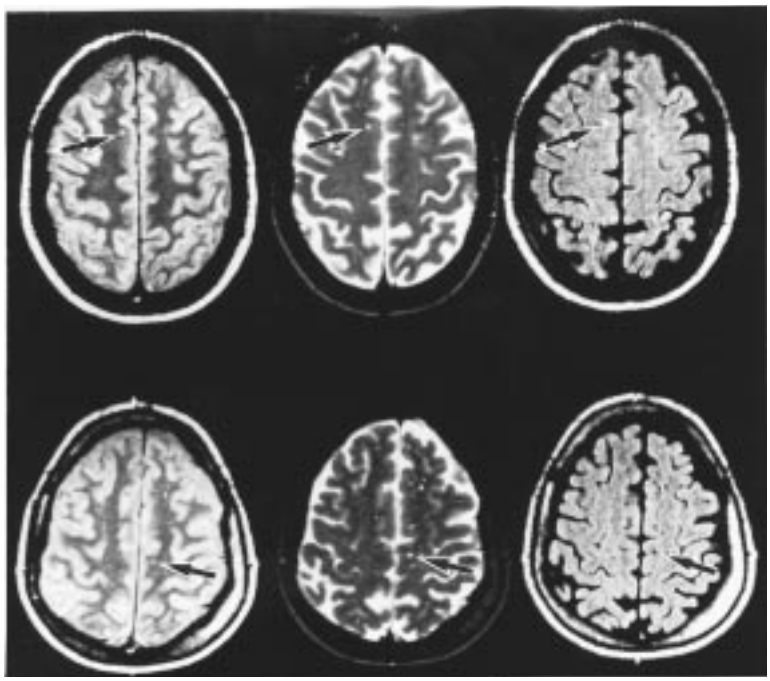

Fig 1 Magnetic resonance images of brains of two divers: proton density weighted (left), T2 weighted (middle), and FLAIR sequence (right). Signal changes in subcortical white matter are identical in left and middle images (arrows), but FLAIR sequences allow differentiation between true brain lesions (top right, arrow) and widened perivascular spaces (bottom right, arrow)

had a history suggestive of multiple sclerosis, and one had suffered severe perinatal asphyxia.

We questioned the remaining subjects about their alcohol consumption, smoking habits, and presence of hypertension, hypercholesterolaemia, and diabetes mellitus. From each diver we obtained a diving history, including total number of scuba dives, number of decompression dives, and events with signs and symptoms suggestive of decompression sickness. We also obtained details of what method the divers used to equalise pressure in the middle ear. This is because pressure equalisation by the Valsalva manoeuvre might lead to an increased arterialisation of nitrogen bubbles in multi-level dives with two or more descents or in repetitive dives with a short surface interval. All the divers but one (who turned out not to have brain lesions) were unaware of whether they had a patent foramen ovale.

Before performing the examinations, we obtained all subjects' informed consent according to the Helsinki declaration. The study was approved by the local ethics committee.

Magnetic resonance imaging

We performed magnetic resonance imaging with a 1.5 Tesla magnetic resonance scanner and acquired axial proton density weighted and T2 weighted images covering the whole brain (24 slices, TR 3000 ms, TE 20 ms and 80 ms, matrix 192×256, slice thickness 5 mm). We also included a FLAIR (fluid attenuated inversion recovery) sequence (TR 8300 ms, TE 80 ms, T1 1500 ms, with identical slice parameters) as part of the protocol in order to improve differentiation between widened perivascular (Virchow-Robin) spaces and true brain lesions (see fig 1). The magnetic resonance images were reviewed independently by two neuroradiologists blinded as to whether a patent foramen ovale was present. A lesion was counted if it was hyperintense on proton density weighted and T2 weighted images and the FLAIR sequence. When the neuroradiologists' interpretations differed they reached a consensus by joint review.

Transcranial Doppler ultrasonography

Transcranial Doppler ultrasonography was performed after the magnetic resonance imaging to avoid possible confounding of the results by cerebral echocontrast embolism. Two transcranial pulsed wave 2 MHz ultrasound probes were attached bilaterally to the patient's head and focused at the M1 segment of the middle cerebral artery. During transcranial monitoring, 5 ml of a commercially available sonographic contrast medium (Echovist) containing air microbubbles (diameter <8 μm) was injected twice into an antecubital vein.

Tests were performed at rest and after the subject had performed the Valsalva manoeuvre to increase or provoke a right-to-left shunt.[15] We considered a right-to-left shunt to be present when five or more air microbubble signals occurred in the Doppler spectra of either middle cerebral artery after the Valsalva manoeuvre. The haemodynamic relevance of the right-to-left shunt was classified as low if <20 air microbubble signals occurred after the Valsalva manoeuvre and high if ≥ 20 signals were detected. Transcranial Doppler ultrasonography has proved to be superior to transthoracic echocardiography for detecting a patent foramen ovale and similar to transoesophageal echocardiography.[16 17]

Statistical analysis

For continuous variables, we used the Mann-Whitney U test to compare the groups (subjects with or without a patent foramen ovale). We compared the group proportions of multiple brain lesions with Fisher's test of exact probability and obtained 95% confidence intervals from scientific statistical tables.[18] The level of significance was set at $P<0.05$.

Results

Subjects

Of the 87 divers who entered the study, 67 were men and 20 women with a mean age of 35.7 (SD 8.9) years, mean height 176.4 (7.6) cm, and mean body weight 77.1 (12) kg. They had performed an average of 565.3 (509.1) scuba dives.

Presence of patent foramen ovale

Twenty five of the subjects were found to have a right-to-left shunt, and the haemodynamic relevance of the shunt was classified as high in 13 cases. The group of divers with a patent foramen ovale was not significantly different from the group without the condition in any variable except body weight (table 1). None of the divers had reported a history of type 2 decompression sickness.

Presence of brain lesions

A total of 41 brain lesions were detected in 11 of the 87 divers. Seven of the divers without a right-to-left shunt

had seven brain lesions (one each), while four of the divers with right-to-left shunt had 34 lesions. Of these four divers, one, with a small patent foramen ovale, had one lesion whereas the other three divers had multiple brain lesions and a patent foramen ovale of high haemodynamic relevance. The lesions had a typical size of 2-3 mm, and all of them were located in the anterior cerebral circulation. The prevalence of brain lesions (single or multiple) was higher in the divers with a patent foramen ovale than in those without (16% *v* 11%), but the difference was not significant (Fisher's exact test P = 0.72).

The three divers with multiple brain lesions were non-smokers, aged in their 40s, and did not have any other vascular risk factors (see fig 2). They had a tendency to have a higher total number of dives than did the other 84 divers (757 *v* 558), but this difference was not significant. Of these three divers, one had 16 lesions, one had 12 lesions, and the third had five lesions. The prevalence of multiple brain lesions was significantly higher in the 25 divers with a patent foramen ovale than in the 62 divers without (12% (95% confidence interval 3% to 31%) *v* 0% (0% to 6%), Fisher's exact test P = 0.022). The difference was even greater for a patent foramen ovale of high haemodynamic relevance: the occurrence of multiple brain lesions in the 13 divers with a large patent foramen ovale was 23% (5% to 54%) compared with 0% (0% to 4%) in all the other divers (Fisher's exact test P = 0.004).

Discussion

The aim of our study was to determine whether a patent foramen ovale (or other right-to-left shunt) increased sport divers' risk of developing brain lesions. We therefore examined the prevalence of multiple brain lesions in divers with or without a right-to-left shunt and did not examine non-diving controls. We found that multiple brain lesions occurred exclusively in divers with a patent foramen ovale of high haemodynamic relevance. Our data therefore suggest that the presence of a patent foramen ovale represents an important risk factor for the development of multiple brain lesions in sport divers even in the absence of type 2 decompression sickness. Whereas single brain lesions are common in non-diving control subjects,[5] multiple brain lesions are unusual.

The association of multiple brain lesions with a large patent foramen ovale supports the hypothesis that the brain lesions were due to arterial gas embolism during or shortly after decompression. A thromboembolic pathogenesis is unlikely because, if that were the case, brain lesions should have been evenly distributed between divers and non-diving controls in the study of Reul *et al*.[5] Furthermore, multiple small brain lesions in the white matter are an unusual finding in patients found to have a patent foramen ovale during cerebrovascular investigation.[19]

It should be remembered, however, that in our study 22 of the 25 divers with a right-to-left shunt, and 10 of the 13 divers with a shunt of high haemodynamic relevance, did not have multiple brain lesions detectable by magnetic resonance imaging. Thus, while a large patent foramen ovale seems to be a risk factor for developing multiple brain lesions, other cofactors are likely to play a role. On the other hand, lesions detectable by magnetic resonance imaging may represent only the tip of an iceberg of cerebral gas embolism in divers. Even in divers with neurological decompression sickness, brain lesions are not always detectable by magnetic resonance imaging.[3] This is similar to results found with patients with a source of cerebral thromboembolism: some patients develop cerebral lesions in the absence of clinical signs and symptoms ("silent infarcts"), while others have no detectable lesions after reversible neurological symptoms (such as transient ischaemic attack).

Table 1 Characteristics of 87 sport divers by presence or absence of right-to-left shunt (values are mean (SD) (mean rank) unless stated otherwise)

	Presence of right-to-left shunt		Mann-Whitney U test (P value)
	Yes (n=25)	No (n=62)	
Body height (cm)	174 (8.5) (36.3)	177 (7.0) (47.1)	583 (0.07)
Body weight (kg)	69.9 (11.0) (28.4)	80 (11.2) (50.3)	385 (<0.01)
Age (years)	35.4 (9.2) (42.5)	35.9 (8.9) (44.6)	738 (0.73)
Total No of dives	574 (495) (45.1)	562 (519) (43.6)	749 (0.8)
No of decompression dives	89 (115) (42.9)	100 (157) (43.8)	747 (0.88)
% Of dives in which Valsalva manoeuvre used*	78 (34.5) (45.4)	73 (37.4) (42.7)	715 (0.65)
Cigarette smoking (pack years)	1.8 (5.3) (39)	5.2 (10.9) (45.3)	650 (0.28)
Alcohol consumption (g/day)	30.9 (20) (44)	33.1 (17.1) (43.3)	749 (0.89)

*For equalising pressure in middle ear.

Reliability of study

Concern was expressed about the study of Reul *et al*[5] in that the self selection of divers might have led to the preferential recruitment of divers who thought that they had cause for concern because they had had minor decompression symptoms, thus creating a bias towards higher numbers of brain lesions in divers.[12 20] This argument is not applicable to our study, as all but one diver (who was found not to have any brain

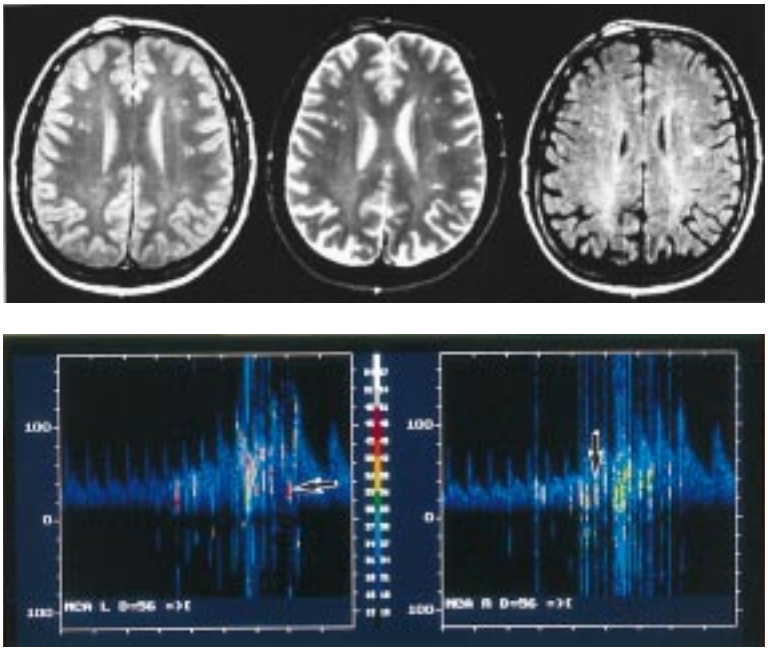

Fig 2 Results for 46 year old male diver (856 dives) without symptoms, no history of decompression incidents, and no history of cerebrovascular disease or known vascular risk factors. Top: magnetic resonance images show multiple lesions in central white matter of brain (hyperintense spots visible on all three images). Bottom: transcranial Doppler ultrasonography after injection of contrast medium shows multiple air microbubbles in left middle cerebral artery after Valsalva manoeuvre (arrow)

lesions) were unaware of whether they had a patent foramen ovale. The difference in the prevalence of multiple brain lesions between the groups of divers with and without patent foramen ovale cannot be explained by this hypothetical bias from self selection.

The group of divers with right-to-left shunts did not differ significantly from those without shunts in any other variable except that they had a lower body weight. Nitrogen—which forms bubbles in divers' tissues during decompression—is 4.5 times more soluble in fat than in water, leading to a higher gas load in divers with a high proportion of body fat. There is, as yet, no hard evidence that this also leads to a higher amount of venous gas bubbles, but even if it did it could not explain our results since the divers with the higher prevalence of multiple brain lesions had lower body weight.

Key messages

- An increased prevalence of multiple brain lesions has been reported in scuba divers compared with non-diving controls
- It has been suggested that the brain lesions were due to arterial gas embolism and that the gas emboli could have entered the arterial circulation via a patent foramen ovale
- We investigated this hypothesis in volunteer sport divers who had made at least 160 scuba dives
- Brain lesions occurred in divers even in the absence of reported decompression sickness
- Multiple brain lesions occurred exclusively in divers with a large patent foramen ovale
- The association of multiple brain lesions with a large patent foramen ovale suggests paradoxical gas embolism as the pathological mechanism

Comparison with other studies

Other studies have found an increased prevalence of a patent foramen ovale or other right-to-left shunt in divers with decompression sickness.[14] The prevalence of a patent foramen ovale was as high as 66% in a subgroup of divers with type 2 decompression sickness of early onset thought to be due to gas embolism. In the absence of reported type 2 decompression sickness, the multiple brain lesions we found in the divers of our study are most likely the consequence of subclinical arterial gas embolism.

Our results are also in accordance with those of Reul *et al*,[5] who found multiple brain lesions in sport divers, most of whom did not have a history of decompression sickness. However, we could not confirm their findings of 86 brain lesions in 52 sport divers: we found only 41 lesions in 87 divers. Moreover, Reul *et al* found at least one brain lesion in more than half of their divers (27/52), whereas we detected brain lesions in only 13% (11/87). Since our study had almost identical inclusion criteria, patient selection can hardly be entirely responsible for such a large difference. For detection of brain lesions, Reul *et al* used axial proton density weighted and T2 weighted magnetic resonance images, in which fluid filled perivascular spaces can be mistaken for brain lesions (see fig 1).[21-23] As the signal of the cerebrospinal fluid is suppressed in FLAIR sequences, sensitivity and specificity in the diagnosis of brain lesions is increased.[23-25] To improve the specificity of our diagnosis, we counted a hyperintense change in signal as a lesion only if it was hyperintense to white matter in T2 weighted and proton density weighted images and in the FLAIR sequence. Thus, the differences between ourselves and Reul *et al* in the reported prevalence of brain lesions in divers may have been due to the different criteria used in the definition of brain lesions. Furthermore, the total number of dives is not apparent from the publication of Reul *et al*, and some of the difference in the frequency of brain lesions might be attributable to different total numbers of dives.

Studies in professional divers have failed to demonstrate an increased risk of developing cerebral lesions. Todnem *et al* and Rinck *et al* found significantly more abnormal neurological and electroencephalographic findings in the professional divers, but they did not find an increased prevalence of hyperintense spots on the magnetic resonance images of the divers' brains.[1 2] All the control subjects were examined with a 1.5 Tesla imager, whereas many of the divers were examined with an imager with a lower field strength (0.5 Tesla). Moreover, the sequence parameters, and therefore the T2 weighting of the images, were different. Thus, the comparability of the groups could be questioned. The authors used only proton density weighted and T2 weighted images, in which perivascular spaces and true brain lesions can be confounded.[21-23] The extremely high prevalence of "spots of high signal intensity" (42%) in the control subjects raises the question of whether many Virchow-Robin spaces were counted, rendering possible differences in the prevalences of true brain lesions insignificant.

While Todnem *et al*'s and Rinck *et al*'s results seem to contradict those of Reul *et al* and our study, Fueredi *et al* found that compressed air tunnel workers had an increased prevalence of brain lesions.[4] Compressed air tunnel workers are subject to compression and decompression, breathe compressed air, and are at risk of decompression sickness just as divers are.

Conclusion

Our study shows an increased prevalence of multiple brain lesions in divers with a patent foramen ovale compared with divers without a patent foramen ovale. In the absence of reported type 2 decompression sickness this finding supports the hypothesis that these lesions are the consequence of subclinical cerebral gas embolism. As about a quarter of all sport divers will have a patent foramen ovale, its association with an increased prevalence of multiple brain lesions means there is an urgent need for further discussion of how a right-to-left shunt affects people's fitness to dive and whether different decompression tables should be developed for such divers.

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Conflict of interest: None

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Cross sectional analysis of mortality by country of birth in England and Wales, 1970-92

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Abstract

Objective: To compare mortalities for selected groups of immigrants with the national average.
Design: Analysis of mortality for adults aged 20-69 in 1970-2 and 1989-92 using population data from 1971 and 1991 censuses. Mortality of Scottish and Irish immigrants aged 25-74 was also compared with mortality in Scotland and Ireland for 1991.
Setting: England and Wales.
Main outcome measures: Standardised mortality ratios for deaths from all causes, ischaemic heart disease, cerebrovascular disease, lung cancer, and breast cancer.
Results: In 1989-92 mortality from all causes was higher than the national average for Scottish immigrants, by 32% for men and 36% for women; for Irish immigrants it was higher by 39% for men and 20% for women; and for Caribbean born men it was lower by 23%. Ischaemic heart disease and lung cancer accounted for 30-40% of the excess mortality in Scottish and Irish immigrants. For south Asians, excess mortality from circulatory disease was balanced by lower mortality from cancer. Standardised mortality ratios for cerebrovascular disease in 1989-92 were highest for west African immigrants (271 for men and 181 for women).
Conclusions: Widening differences in mortality ratios for migrants compared with the general population were not simply due to socioeconomic inequalities. The low mortality from all causes for Caribbean immigrants could largely be attributed to low mortality from ischaemic heart disease, which is unexplained. The excess mortality from cerebrovascular and hypertensive diseases in migrants from both west Africa and the Caribbean suggests that genetic factors underlie the susceptibility to hypertension in people of black African descent.

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Introduction

Country of birth has been recorded on death certificates in England and Wales since 1970. Two previous studies of immigrant mortality indicated differences by country of birth that varied with cause of death.[1 2] Our analysis of mortality by country of birth in 1989-92 provides an updated version of previous analyses and permits examination of mortality trends by country of birth.

Subjects and methods

Data on populations

We used published population data from the 1971 and 1991 censuses of England and Wales for analyses of

Table 1 Age distributions of total population and selected immigrant groups aged 20-69 years in England and Wales (from 1991 census[3])

Country of birth*	No (%) of subjects in age range		
	20-44 years	45-59 years	60-69 years
Men			
Total population	9 072 779 (58)	4 173 184 (27)	2 388 626 (15)
Scotland	170 353 (55)	91 329 (29)	48 076 (16)
Ireland	132 246 (43)	112 858 (37)	62 427 (20)
East Africa	81 545 (81)	16 388 (16)	3 393 (3)
West Africa	33 679 (77)	8 432 (19)	1 801 (4)
Caribbean	39 889 (35)	50 127 (44)	23 935 (21)
South Asia	179 827 (56)	100 238 (32)	38 740 (12)
Women			
Total population	9 222 510 (57)	4 187 165 (26)	2 660 595 (17)
Scotland	159 504 (55)	79 535 (28)	50 433 (17)
Ireland	144 280 (44)	117 003 (35)	70 398 (21)
East Africa	76 236 (81)	14 873 (16)	3 082 (3)
West Africa	37 740 (82)	7 218 (16)	1 005 (2)
Caribbean	56 529 (44)	52 386 (41)	18 399 (14)
South Asia	198 353 (63)	85 154 (27)	31 875 (10)

*See text for full explanation of immigrant groups.

mortality of immigrant groups and from 1991 censuses of Scotland, Northern Ireland, and the Republic of Ireland for analyses of deaths in these countries.[3-7] Our study included immigrants from Scotland, Ireland, Africa, the Caribbean Commonwealth, and the Indian subcontinent (south Asia).

We analysed separately data for immigrants from east African countries and for those from west and south African Commonwealth countries (abbreviated to east Africa and west Africa respectively). Previous studies combined data on all immigrants from east Africa, 68% of whom are of south Asian origin, and from west Africa, 73% of whom are of black African origin.[3] White immigrants were the second largest ethnic group from both of these groups of countries (16% and 22% of immigrants from east Africa and west Africa respectively).[3] The countries included in "east Africa" were Kenya, Malawi, Tanzania, Uganda, and Zambia, while those included in "west Africa" were Gambia, Ghana, Sierra Leone, Nigeria, Botswana, Lesotho, Swaziland, and Zimbabwe. We combined the Republic of Ireland and Northern Ireland and grouped together the countries in south Asia (Bangladesh, India, Sri Lanka, and Pakistan) to avoid numerator-denominator bias (that is, when country of birth is recorded differently on census and death certificate). This has been identified as a particular problem with data on death certificates for people born in these groups of countries.[1] In our tables we presented the countries in the order in which they appeared in the census.

Data on deaths

The Office of Population Censuses and Surveys provided data on deaths by country of birth, sex, and age for people aged 20-74 years who died in England and Wales between 1970 and 1992. We obtained data on deaths by sex and age for England and Wales for 1971, and for Scotland and the Irish republic and Northern Ireland for 1991 from the World Health Organisation's statistics annuals, which provide data in 10 year age bands for people aged 25-74.[4 8 9] We recorded the underlying cause of death, coded according to the *International Classification of Diseases*, eighth and ninth revisions (ICD-8 and ICD-9).[10 11]

Statistical analysis

We examined deaths of people aged 20-69 by country of birth for 1970-2 and 1989-92. Consistent with previous studies of immigrant mortality, the reference death rates we used for calculating standardised mortality ratios were generated using numbers of deaths and population figures by sex and five year age group for the whole population of England and Wales during 1989-92. We calculated standardised mortality ratios and 95% confidence intervals by sex and country of birth for people aged 20-69 using conventional methods.[12]

Population data for Scottish and Irish immigrants in England and Wales were not available for the age range 25-74 for 1971, and we therefore could not compare mortality trends from 1971 to 1991 for immigrants with their countries of origin. We calculated standardised mortality ratios for Scotland and Ireland and for Scottish and Irish immigrants aged 25-74 in 1991 using death rates in England and Wales in 1991 as the standard.

Table 2 Numbers of deaths from all causes and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92

		Men		Women	
Country of birth*	Period	No of deaths	Standardised mortality ratio (95% CI)	No of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	405 440	141 (140 to 142)	238 076	127 (126 to 128)
	1989-92	385 203	100	239 343	100
Scotland	1970-2	8 561	158 (155 to 162)	4 229	138 (134 to 143)
	1989-92	10 439	132 (129 to 135)	6 214	136 (133 to 140)
Ireland	1970-2	10 547	173 (170 to 176)	5 590	151 (147 to 155)
	1989-92	13 488	139 (137 to 142)	7 436	120 (117 to 123)
East Africa	1989-92	1 202	110 (104 to 116)	590	103 (95 to 112)
West Africa	1989-92	598	113 (104 to 122)	305	126 (112 to 141)
Caribbean	1970-2	1 326	132 (125 to 140)	878	180 (168 to 192)
	1989-92	2 927	77 (74 to 79)	1 798	91 (87 to 95)
South Asia	1970-2	3 007	137 (132 to 142)	1 442	145 (138 to 153)
	1989-92	7 589	106 (103 to 108)	3 581	100 (97 to 103)

*See text for full explanation of immigrant groups.

Results

Population changes

Between 1971 and 1991 the proportions of Caribbean and south Asian immigrant populations in older age groups increased, because the largest influx of immigrants from these countries occurred before 1965. Of the 20-69 year old population counted in the census, the proportion aged 50-69 increased among Caribbean immigrants from 12% in 1971 to 49% in 1991 and increased among south Asian immigrants from 18% to 31%. The size of the Caribbean immigrant population aged 20-69 stayed roughly constant (237 085 in 1971 and 241 265 in 1991), but the south Asian population in this age range almost doubled (351 120 in 1971 and 634 187 in 1991). As a result of these factors, the numbers of deaths of immigrants born in the Caribbean and south Asia increased between 1971 and 1991.

With continuing migration to and from Scotland and Ireland, the age distributions of Scottish and Irish immigrants remained roughly constant.

The proportions of deaths in England and Wales accounted for by immigrants from the countries studied were 5.5% in 1970-2 and 9% in 1989-92. The age distributions of the populations by country of birth differed from that of the whole population of England and Wales as shown in table 1.

Mortality from all causes

Mortality ratios for deaths from all causes were higher than the national average for all the immigrant groups except for Caribbean immigrants (table 2). Mortality from all causes fell in all groups between 1971 and 1991, with the national average declining 31% for men and 24% for women. Declines were least for men and women born in Scotland (16.5% and 1.5% respectively) and greatest for men and women born in the Caribbean (41% and 49%). The relatively small decline for Scottish immigrants, a group with high mortality ratios from all causes, and the large decline for Caribbean immigrants, whose mortality from all causes was already low, indicates widening differences in mortality by country of birth over the 20 year period.

This pattern was generally repeated for specific causes of death, except for the substantial fall in cerebrovascular mortality ratios for Caribbean immigrants. Ischaemic heart disease, cerebrovascular disease, and lung cancer accounted for 40% of the excess deaths in Scottish and Irish immigrants. For Caribbean immigrants the lower mortality from ischaemic heart disease outweighed the higher mortality from cerebrovascular disease; lower mortality from ischaemic heart disease and lung cancer accounted for 88% of the difference in mortality from all causes between Caribbean men and the national average.

Cardiovascular disease

Ischaemic heart disease was the leading cause of death for men and women for all population groups with the exception of women immigrants from west Africa, who were relatively young. Standardised mortality ratios for ischaemic heart disease were highest for south Asian men and women and east African men and lowest for Caribbean and west African immigrants in 1989-92 (see table 3). Table 4 shows standardised mortality ratios for ischaemic heart disease by different age groups for 1989-92: differences between men by country of birth were even greater for the youngest age group (20-44 years).

From 1971 to 1991 the national average standardised mortality ratios for ischaemic heart disease fell by 29% for men and by 17% for women. Caribbean immigrants showed a steeper decline (38% for men and 40% for women), and south Asian immigrants showed a shallower decline (20% for men and 7% for women).

Mortality ratios for cerebrovascular disease were higher than the national average for all immigrant groups in 1989-92, the highest ratios being for west African immigrants (table 5). The national average decline in age standardised mortality from cerebrovascular disease over the study period was 50% for men and 52% for women. The greatest decline occurred in Caribbean immigrants (57% for men and 66% for women), but their standardised mortality ratios for cerebrovascular disease remained elevated. Scottish, Irish, and south Asian immigrants showed smaller declines in mortality from cerebrovascular disease than the national average.

Analyses of mortality from hypertensive diseases (ICD codes 401-405) were based on small numbers of deaths. They showed a similar pattern of differences between immigrant groups as did those for cerebrovascular disease, though the actual differences were more pronounced. Standardised mortality ratios were 813 for west African men (95% confidence interval 503 to 1242, based on 21 deaths), 373 for Caribbean men (296 to 462, 82 deaths), 944 for west African women

Table 3 Numbers of deaths from ischaemic heart disease (ICD codes 410-414) and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92

		Men		Women	
Country of birth*	Period	No of deaths	Standardised mortality ratio (95% CI)	No of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	134 093	146 (145 to 148)	43 234	123 (121 to 125)
	1989-92	123 741	100	44 110	100
Scotland	1970-2	2 996	172 (166 to 178)	826	154 (144 to 165)
	1989-92	3 066	120 (116 to 124)	1 099	130 (122 to 137)
Ireland	1970-2	3 113	160 (154 to 166)	950	154 (144 to 164)
	1989-92	3 995	124 (120 to 127)	1 398	120 (114 to 126)
East Africa	1989-92	372	131 (118 to 145)	73	105 (82 to 132)
West Africa	1989-92	81	56 (44 to 70)	16	62 (35 to 100)
Caribbean	1970-2	198	74 (64 to 85)	65	119 (92 to 151)
	1989-92	592	46 (42 to 49)	236	71 (61 to 80)
South Asia	1970-2	1 140	183 (172 to 193)	255	162 (143 to 183)
	1989-92	3 348	146 (141 to 151)	882	151 (141 to 162)

*See text for full explanation of immigrant groups.

Table 4 Age distribution of numbers of deaths from ischaemic heart disease (ICD codes 410-414) and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the period 1989-92

	Men		Women	
Country of birth*	No of deaths	Standardised mortality ratio (95% CI)	No of deaths	Standardised mortality ratio (95% CI)
Ages 20-44 years				
Total population	5 312	100 (97 to 103)	889	100 (94 to 107)
Scotland	163	142 (121 to 165)	19	109 (66 to 170)
Ireland	138	149 (125 to 175)	20	120 (73 to 186)
East Africa	71	153 (119 to 193)	5	73 (24 to 171)
West Africa	13	74 (39 to 127)	0	0 (0 to 118)
Caribbean	13	45 (24 to 76)	7	97 (39 to 199)
South Asia	193	169 (146 to 195)	24	118 (75 to 175)
Ages 45-59 years				
Total population	36 811	100 (99 to 101)	8 513	100 (98 to 102)
Scotland	974	125 (117 to 133)	235	153 (134 to 174)
Ireland	1 357	132 (125 to 140)	345	141 (127 to 157)
East Africa	171	130 (111 to 151)	31	116 (79 to 165)
West Africa	37	53 (38 to 73)	5	45 (15 to 106)
Caribbean	239	48 (42 to 55)	83	74 (59 to 92)
South Asia	1 456	158 (150 to 166)	257	153 (135 to 173)
Ages 60-69 years				
Total population	81 618	100 (99 to 101)	34 708	100 (99 to 101)
Scotland	1 929	116 (111 to 121)	845	125 (116 to 133)
Ireland	2 500	118 (114 to 123)	1 033	114 (107 to 121)
East Africa	130	122 (102 to 145)	37	103 (72 to 142)
West Africa	31	54 (38 to 76)	11	93 (47 to 167)
Caribbean	340	44 (39 to 49)	146	67 (57 to 79)
South Asia	1 699	135 (128 to 141)	601	152 (140 to 165)

*See text for full explanation of immigrant groups.

Table 5 Numbers of deaths from cerebrovascular disease (ICD codes 430-438) and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92

		Men		Women	
Country of birth*	Period	No of deaths	Standardised mortality ratio (95% CI)	No of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	31 271	195 (191 to 199)	27 428	206 (202 to 210)
	1989-92	21 421	100	17 334	100
Scotland	1970-2	533	183 (168 to 199)	425	198 (180 to 218)
	1989-92	554	125 (115 to 136)	416	125 (113 to 137)
Ireland	1970-2	756	234 (154 to 166)	596	235 (216 to 254)
	1989-92	758	138 (128 to 148)	553	123 (113 to 133)
East Africa	1989-92	56	114 (86 to 147)	43	122 (88 to 164)
West Africa	1989-92	67	271 (210 to 344)	26	181 (118 to 265)
Caribbean	1970-2	177	394 (338 to 457)	137	463 (389 to 547)
	1989-92	360	168 (151 to 186)	212	157 (136 to 179)
South Asia	1970-2	244	226 (198 to 256)	165	246 (210 to 286)
	1989-92	594	155 (143 to 168)	344	141 (127 to 157)

*See text for full explanation of immigrant groups.

Table 6 Numbers of deaths from lung cancer (ICD code 162) and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92

		Men		Women	
Country of birth*	Period	No of deaths	Standardised mortality ratio (95% CI)	No of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	48 687	157 (155 to 159)	10 449	68 (65 to 71)
	1989-92	41 152	100	19 179	100
Scotland	1970-2	1 025	181 (170 to 192)	250	103 (91 to 117)
	1989-92	1 260	149 (141 to 157)	616	169 (156 to 182)
Ireland	1970-2	1 154	185 (174 to 196)	336	118 (105 to 131)
	1989-92	1 625	151 (143 to 158)	749	147 (136 to 158)
East Africa	1989-92	35	42 (29 to 58)	6	17 (6 to 37)
West Africa	1989-92	27	62 (41 to 90)	7	51 (21 to 106)
Caribbean	1970-2	49	65 (48 to 85)	7	25 (10 to 51)
	1989-92	210	49 (42 to 56)	49	31 (23 to 41)
South Asia	1970-2	148	76 (65 to 90)	32	44 (30 to 62)
	1989-92	338	45 (41 to 51)	90	33 (27 to 41)

*See text for full explanation of immigrant groups.

(432 to 1792, 9 deaths), and 668 for Caribbean women (524 to 840, 73 deaths).

Malignant neoplasms

Mortality ratios for lung cancer were high for men and women from Scotland and Ireland and low in the other immigrant groups (table 6). In men the mortality ratios declined by between 18% (for Scottish men) and 41% (for south Asian men). In women, however, the mortality ratios increased: the national average by 47%, by 64% for Scottish women, and by 25% for Irish women. Relative risks of mortality from lung cancer by country of birth were roughly equal in 1971 and 1991.

There were relatively small numbers of deaths from breast cancer in immigrant groups, but women born in Ireland, the Caribbean, and south Asia showed low mortality ratios (table 7). From 1971 to 1991 the national average mortality ratio for breast cancer did not change, and low rates in Caribbean and south Asian women persisted.

Comparison with mortality in Scotland and Ireland

Mortality ratios for all causes and for ischaemic heart disease were higher in Scotland and Ireland than in England and Wales (table 8). Scottish men and Irish men and women who were immigrants showed higher standardised mortality ratios for all causes than did the comparable groups resident in Scotland and Ireland. Irish immigrants showed greater excess mortality from all causes over the population resident in the country of origin than did Scottish immigrants. Mortality from ischaemic heart disease was higher for residents in Scotland than for Scottish immigrants but was higher for Irish immigrants than for residents in Ireland.

Discussion

Validity of results

The estimation of trends in mortality involves the comparison of two standardised mortality ratios, which is valid only if the proportional hazard model applies. When relative risks differ between age groups, as for mortality from ischaemic heart disease, it is more appropriate to report age-specific mortality ratios as in table 4.[13] The low standardised mortality ratios for all causes in Caribbean immigrants were mainly attributable to low mortality from ischaemic heart disease. It is unlikely that the effect of return migration of sick people could be entirely responsible for the low mortality because about half of all fatal coronary events occur in the absence of previous symptoms.[14]

Overall, no census data were obtained for 2.2% of the population in 1991. Completeness of enumeration varied with population characteristics, and underenumeration was greatest in Afro-Caribbean men aged 20-29.[15-17] The effect of such underenumeration would be to increase apparent mortality in affected populations, which could not explain the low death rates found for Caribbean immigrants.

Reasons for different mortality patterns

Mortality patterns for 1989-92 were similar to those reported around the 1971 and 1981 censuses.[1 2] One possible explanation for high mortality ratios in men and women born in Scotland and Ireland is selection of less fit individuals at migration. Ill health is less likely to inhibit migration to England and Wales for people born in Scotland and Ireland than it is for people from more distant countries for which there are restrictions on immigration. The persistent excess mortality in second generation Irish people in

Table 7 Numbers of deaths from breast cancer in women (ICD code 174) and standardised mortality ratios for total population and selected immigrant groups aged 20-69 years in England and Wales for the periods 1970-2 and 1989-92

Country of birth*	Period	No of deaths	Standardised mortality ratio (95% CI)
Total population	1970-2	21 202	100 (97 to 102)
	1989-92	27 437	100
Scotland	1970-2	362	96 (86 to 106)
	1989-92	593	114 (105 to 124)
Ireland	1970-2	410	86 (78 to 95)
	1989-92	661	92 (85 to 99)
East Africa	1989-92	68	84 (65 to 107)
West Africa	1989-92	44	125 (91 to 168)
Caribbean	1970-2	56	79 (59 to 102)
	1989-92	196	75 (65 to 87)
South Asia	1970-2	92	74 (59 to 90)
	1989-92	269	59 (52 to 66)

*See text for full explanation of immigrant groups.

England and Wales,[18 19] however, is not consistent with a selection explanation.

Previous studies have shown that social class did not account for the increased mortality in Irish immigrants, which was higher than the average for England and Wales within each social class.[18 20] Mortality from lung cancer can be used as a proxy measure of smoking in populations, and the high standardised mortality ratios for lung cancer in Scottish and Irish immigrants suggest that smoking habits may account for some of the excess of ischaemic heart disease.[21]

Adverse environmental conditions (deprivation, poor working conditions, lack of social support, unhealthy lifestyle, etc) in the country of origin may have long term effects on immigrants and may persist or develop in the host country.[22] The low mortality from all causes that we observed in Caribbean immigrants cannot be explained by a favourable social class distribution because a higher proportion of people of Afro-Caribbean ethnic origin are manual workers (70%) than in the whole population (52%).[3]

High standardised mortality ratios for ischaemic heart disease and cerebrovascular disease in south Asian men and women are consistent with the high rates of ischaemic heart disease in this group worldwide and are associated with increased prevalences of central obesity and insulin resistance.[23] It is not clear why Afro-Caribbean people, in whom prevalences of diabetes and hypertension are high, have relatively low rates of ischaemic heart disease.[24 25] The relative advantage of Caribbean men with regard to mortality from all causes and from ischaemic heart disease was preserved from 1971 to 1991, in contrast with the expectation that mortalities of immigrant populations would approximate to those of the host population over time.

High rates of cerebrovascular disease in Caribbeans and west Africans are consistent with survey data showing that they have higher mean blood pressures than Europeans in London[24] and high prevalences of hypertension in their countries of origin.[26] As migrants from the Caribbean and from west Africa have not shared a common environment for the past 300 years, a genetic explanation for the susceptibility to hypertension in people of west African descent is likely. The high mortality from diseases related to hypertension in migrants from west Africa does not support the hypothesis that black people in the United States are more prone to hypertension as a result of selective survival of slaves able to retain salt.[27] The extremely high mortality from cerebrovascular disease in Caribbean immigrants noted around the 1971 census became less pronounced in 1991, suggesting that detection and control of hypertension have improved in this group. In a recent survey more than two thirds of Afro-Caribbean men and women with hypertension were found to be receiving treatment.[24]

The findings of our study suggest a need for general health promotion programmes targeted at Irish and Scottish immigrants and specific health promotion programmes focused on preventing cerebrovascular disease in west Africans.

Table 8 Standardised mortality ratios for deaths from all causes and from ischaemic heart disease in 1991 for residents of Scotland and Ireland and for Scottish and Irish immigrants in England and Wales aged 25-74

	Men		Women	
Group	No of deaths	Standardised mortality ratio (95% CI)*	No of deaths	Standardised mortality ratio (95% CI)*
Deaths from all causes				
Residents of Scotland	15 978	122 (120 to 124)	11 274	130 (128 to 132)
Scottish immigrants	3 747	131 (127 to 135)	2 271	133 (128 to 139)
Residents of Ireland	12 229	110 (108 to 112)	7 751	107 (105 to 109)
Irish immigrants	4 583	135 (131 to 179)	2 758	122 (117 to 127)
Deaths from ischaemic heart disease				
Residents of Scotland	5 389	127 (124 to 130)	2 795	151 (145 to 157)
Scottish immigrants	1 093	117 (110 to 124)	424	114 (108 to 120)
Residents of Ireland	4 097	114 (111 to 118)	1 651	107 (102 to 112)
Irish immigrants	1 362	121 (115 to 128)	629	127 (118 to 137)

*Standardised to death rates for total population in England and Wales in 1991.

Key messages

- Differences in mortality of immigrants in England and Wales widened between 1970 and 1992 and could not be explained by socioeconomic differences
- Mortality from all causes was higher than average for Scottish and Irish immigrants, and some of the excess could be accounted for by smoking habits, reflected by increased mortality ratios for lung cancer
- Mortality ratios for stroke and hypertension were highest in west African immigrants, indicating that better detection and treatment of hypertension is required in this group
- Mortality from all causes was low in Caribbean immigrants, largely due to low mortality from ischaemic heart disease
- Mortality from ischaemic heart disease remained high in south Asian immigrants and did not decline as fast as in the general population

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Influence of changing travel patterns on child death rates from injury: trend analysis

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Abstract

Objectives: To examine trends in child mortality from unintentional injury between 1985 and 1992 and to find how changes in modes of travel contributed to these trends.
Design: Poisson regression modelling using data from death certificates, censuses, and national travel surveys.
Setting: England and Wales.
Subjects: Resident children aged 0-14.
Main outcome measures: Deaths from unintentional injury and poisoning.
Results: Child deaths from injury declined by 34% (95% confidence interval 28% to 40%) per 100 000 population between 1985 and 1992. Substantial decreases in each of the leading causes of death from injury contributed to this overall decline. On average, children walked and cycled less distance and travelled substantially more miles by car in 1992 compared with 1985. Deaths from road traffic accidents declined for pedestrians by 24% per mile walked and for cyclists by 20% per mile cycled, substantially less than the declines per 100 000 population of 37% and 38% respectively. In contrast, deaths of occupants of motor vehicles declined by 42% per mile travelled by car compared with a 21% decline per 100 000 population.
Conclusions: If trends in child mortality from injury continue the government's target to reduce the rate by 33% by the year 2005 will be achieved. A substantial proportion of the decline in pedestrian traffic and pedal cycling deaths, however, seems to have been achieved at the expense of children's walking and cycling activities. Changes in travel patterns may exact a considerable price in terms of future health problems.

Introduction

In 1990 injuries were the leading cause of child death after the first year of life.[1] The national strategy for improving health, *Health of the Nation*, has set a target of a 33% reduction in child mortality from unintentional injury by the year 2005.[2] Focusing solely on reducing deaths from injury, however, may lead to unintended consequences for other aspects of child health. We used data from death certificates and national travel surveys to assess the extent to which trends in mortality from transport related injury reflect changes in children's travel patterns.

Methods

We obtained an anonymised data file of all deaths from injury in children (aged 0-14 years) between 1985 and 1992 in England and Wales from the Office of National Statistics. Each record included age, sex, external cause of injury (E code),[3] and year of death. We excluded 28 records (0.5%) missing the specific age at death. Total deaths from accidental injury and subgroups for specific causes were defined by the E codes as shown in table 1. We used annual numbers of deaths rather than annual numbers of death registrations as published in routine mortality data. Death registrations significantly misclassify year of death, since up to a third of deaths from injury each year are registered in later years, often because results of inquests are pending.

The national travel surveys periodically collect data on the average annual number of miles that British residents travel by various modes, based on seven-day personal travel diaries.[4] We analysed unpublished data from 1985-6, 1989-91, and 1992-4 (Department of Transport, 1996) for children aged 0-14 years and resident in England or Wales. We interpolated the annual distance travelled by each mode for each year from 1985 to 1992 to calculate annual death rates of pedestrians, cyclists, and occupants of motor vehicles per mile travelled by walking, cycling, and riding in cars respectively.

We used published census data to calculate death rates from injury per 100 000 population. We found no changes in age distribution over time and so have pre-

Table 1 Number of deaths from unintentional injury in children aged 0-14 years during 1985-92 in England and Wales and cumulative declines in death rates between 1985 and 1992

Type of accidental injury*	No (%) of deaths	% Decline (95% CI) in death rate†
All injuries:	5392	34 (28 to 40)
Boys	3558 (66)	30 (22 to 36)
Girls	1834 (34)	36 (27 to 45)
Road traffic accident:		
Pedestrian:	1701 (32)	37 (27 to 45)
Boys	1115 (21)	32 (20 to 44)
Girls	586 (11)	43 (27 to 55)
Occupant of motor vehicle:	617 (11)	21 (0 to 39)
Boys	323 (6)	6 (–31 to 32)
Girls	294 (5)	35 (8 to 54)
Cyclist:	413 (8)	38 (16 to 53)
Boys	347 (6)	30 (3 to 49)
Girls	66 (1)	66 (28 to 84)
Fire and flames:	711 (13)	30 (11 to 44)
Boys	426 (8)	37 (16 to 53)
Girls	285 (5)	14 (–22 to 40)
Suffocation and aspiration:	586 (11)	32 (14 to 47)
Boys	407 (8)	26 (0 to 45)
Girls	179 (3)	46 (15 to 65)
Drowning and submersion:	451 (8)	27 (4 to 45)
Boys	343 (6)	30 (3 to 48)
Girls	108 (2)	20 (–43 to 55)
All other accidental injuries:	913 (17)	31 (17 to 45)
Boys	597 (11)	31 (12 to 46)
Girls	316 (6)	32 (5 to 51)

*Office of National Statistics codes for external cause of injury (E codes): all accidental injuries (E800-949); pedestrian in road traffic accident (E810-819 ending in .7); occupant of motor vehicle in road traffic accident (E810-819 except ending in .6 or .7); cyclist in road traffic accident (E810-819 ending in .6, E826); fire and flames (E890-899); suffocation and aspiration (E911-913); drowning and submersion (E910).
†Death rate=No of deaths/100 000 population.

sented crude rates. We quantified trends in deaths per capita and per mile for 1985-92 using Poisson regression modelling, with death rate as the dependent variable and year as the explanatory variable.[5] For specific causes of death, we recalculated death rates for the subgroups with fewer than 100 deaths annually using three-year moving averages (two-year averages for 1985 and 1992) to minimise effects of random variability. A detailed tabulation of deaths and death rates among children and teenagers in England and Wales in 1992 will be published elsewhere.[6]

Results

There were 5392 child deaths from unintentional injury in England and Wales between 1985 and 1992. Pedestrian deaths in road traffic accidents accounted for the largest portion of these deaths (table 1). Other leading causes of death included fire and flames, motor vehicle traffic accidents, and suffocation and aspiration. The total mortality from unintentional injury declined 5.7% per year between 1985 and 1992, a cumulative decline of 34% (table 1). Death rates also declined for each of the leading causes of death from unintentional injury (fig 1).

Boys accounted for 3558 deaths (66%) and girls for 1834 deaths (34%) (table 1). The ratio of boys to girls varied considerably by cause of death, ranging from 1:1 for occupants of motor vehicles in road traffic accidents to more than 5:1 for cyclists in road traffic accidents. For several categories, cumulative declines in death rates seemed to differ by sex, although the precision of these point estimates was low, especially for girls.

Between 1985 and 1992, the average distance walked in a year by a child aged 0-14 declined by 20%, from 247 miles (398 km) to 197 miles (319 km). The average distance cycled in a year fell 26%, from 38 miles (61 km) to 28 miles (45 km). In contrast, the average distance that children travelled by car in a year increased 40%, from 2259 miles (3635 km) to 3158 miles (5082 km). Girls showed substantially larger declines in walking (30%) and cycling (64%) and smaller increases in car travel (35%) than did boys (18%, 30%, and 45%, respectively). Children aged 10-14 showed the largest decline in walking (35%) compared with children aged 0-4 (10%) and 5-9 (20%). Declines in cycling mileage did not vary by age.

Table 2 shows the cumulative declines in deaths of pedestrians, cyclists, and occupants of motor vehicles per mile travelled by foot, cycle, and car respectively along with declines per 100 000 population. Because of small numbers in some categories, age specific and sex specific rates must be interpreted with caution. Number of deaths and annual distance cycled among pedal cyclists aged 0-4 were insufficient for reliable trend estimates.

Discussion

If current downward trends in child death rates from injury continue, we will have no difficulty achieving the national target set in the *Health of the Nation*.[2] For transport related deaths, however, these declines seem to have occurred at the expense of children's walking and cycling activities. It is possible that the safety of walking and cycling has improved, as suggested by declines in

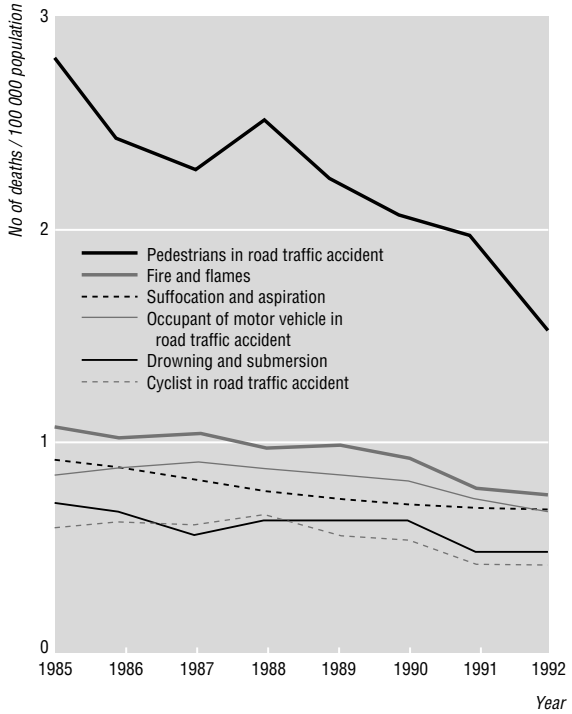

Fig 1 Changes in mortality from specific causes for children aged 0-14 years between 1985 and 1992

Table 2 Cumulative declines in deaths of children aged 0-14 years in road traffic accidents between 1985 and 1992 in England and Wales

Type of road user	% Decline (95% CI) in No of deaths/mile	% Decline (95% CI) in No of deaths/100 000 population
Pedestrian:	24 (12 to 34)	37 (27 to 45)
Aged 0-4 years	30 (7 to 48)	35 (13 to 52)
Aged 5-9 years	30 (13 to 45)	40 (25 to 52)
Aged 10-14 years	13 (–15 to 30)	30 (13 to 45)
Boys	23 (8 to 36)	32 (20 to 44)
Girls	29 (9 to 45)	43 (27 to 55)
Cyclist:	20 (–9 to 40)	38 (16 to 53)
Aged 0-4 years*		
Aged 5-9 years	48 (0 to 73)	30 (–32 to 74)
Aged 10-14 years	13 (–23 to 40)	38 (9 to 53)
Boys	13 (–19 to 37)	30 (3 to 49)
Girls	50 (–7 to 77)	66 (28 to 84)
Occupant of motor vehicle:	42 (26 to 54)	21 (0 to 39)
Aged 0-4 years	40 (13 to 59)	25 (–15 to 48)
Aged 5-9 years	59 (30 to 76)	40 (0 to 62)
Aged 10-14 years	25 (–7 to 45)	7 (–41 to 35)
Boys	32 (6 to 51)	6 (–31 to 32)
Girls	51 (30 to 65)	35 (8 to 54)

*Numbers insufficient for reliable estimates.

deaths per mile walked and cycled. However, concurrent reductions in case fatality rates probably account for much of these declines.[7] The much greater declines in pedestrian and cycling deaths per capita compared with deaths per mile reflect large declines in the distances children walk and cycle.

On the other hand, deaths of occupants of motor vehicles per mile travelled declined by almost half between 1985 and 1992, suggesting that, along with reductions in case fatality rates, car travel became a great deal safer. There was only a small effect of increasingly safe car travel on deaths of of occupants of motor vehicles per capita, however, because children now travel many more miles by car each year.

Differences in mortality by age and sex

In general, in each age group and sex, the relative differences between the decline in transport related deaths per mile and the decline per capita were similar to the overall declines. Greater declines in deaths per capita among girls may reflect their increasingly restricted travel—that is, their greater decline in walking and cycling and smaller increase in car travel compared with boys.

Larger declines in pedestrian deaths per mile walked among children aged under 10 compared with older children may reflect an increasing tendency for young children to be escorted by adults,[8] making walking a safer activity for them. At least some of the differential decline by age and sex in cycling deaths per mile might be due to differential increases in the use of cycle helmets.[9]

Reasons for the large differential declines by age and sex in deaths of occupants of motor vehicles per mile are unclear. They might be explained if there were differential trends that affected safety of car travel—for example, differences in use and effectiveness of safety restraints or in type of car journey—or that affected case fatality rates after injury.

Shortcomings of study

Deficiencies in completeness or reliability of death certificates are unlikely to have systematically biased our results: all the key variables were complete, underreporting of injury as the cause of death is rare for young people,[10] and there were no changes in assignment rules for cause of transport related death during the period studied. Because of small differences over time in the representation of London residents in the national travel surveys,[4] we may have slightly overestimated the contribution of declines in distance cycled, and underestimated the contribution of declines in distance walked, to downward trends in death rates among cyclists and pedestrians. These differences would have had little effect on our overall results, however.

Implications for child health

While declines in children's walking and cycling may reduce traffic related deaths, they can otherwise adversely affect child health.[11 12] Reduced cycling and walking have undoubtedly contributed to declines in overall physical activity, a cause of increasing obesity in British children,[13 14] and potentially of increased obesity in adulthood with its associated risk of chronic disease and death.[15] The curtailment of independent mobility may also have important adverse effects on children's mental, physical, and emotional development.[11] It is likely that declines in walking and cycling were smaller among children of lower socioeconomic status because they have fewer alternatives for play or transportation.[12 16] This differential exposure to traffic related risk may have contributed to divergent trends in death rates from injury by social class.[17]

Reduced walking and cycling, and increased car travel, may thus exact important societal costs by increasing future health problems and widening socioeconomic disparities in child death rates. The targets in the *Health of the Nation* are part of the national

Key messages

- Injuries are the leading cause of death in children over 1 year old, and we assessed the extent to which trends in mortality from transport related injury reflected changes in children's travel patterns
- Child mortality from accidental injury declined by 34% between 1985 and 1992, while children walked and cycled less distance and travelled substantially more by car in 1992 compared with 1985
- Substantial decreases in deaths from road traffic accidents for pedestrians and cyclists were at the expense of walking and cycling activities
- Car travel became safer for children, but the effect on mortality was largely nullified by large increases in the distances children travel by car
- Although these changes are in accordance with government targets to reduce child mortality from accidental injury, the associated decline in children's physical activity may lead to future health problems

strategy to improve health. For child injury deaths, we risk hitting the target but completely missing the point.

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Senior house officers' work related stressors, psychological distress, and confidence in performing clinical tasks in accident and emergency: a questionnaire study

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Abstract

Objective: To investigate the relation between accident and emergency senior house officers' psychological distress and confidence in performing clinical tasks and to describe work related stressors.
Design: Questionnaire survey with data collected at four points during senior house officers' six month attachment to accident and emergency departments.
Subjects: 171 newly appointed accident and emergency senior house officers from 27 hospitals in the South Thames region.
Main outcome measures: Psychological distress measured with a 25 item questionnaire; confidence in performing a range of 35 clinical and practical activities (visual analogue scales); reported consultation stress factors, other work related stressors, and personal stressors.
Results: Overall confidence scores in carrying out a range of clinical and practical activities increased significantly between the end of the first and the end of the fourth month ($Z = -6.05$, $P < 0.001$). Senior house officers with higher psychological distress scores at the end of their first and fourth month had significantly lower confidence scores ($Z = -3.20$, $P < 0.001$; $Z = -1.90$, $P < 0.05$). Senior house officers with lower increases in confidence between the first and fourth month had significantly higher distress than those with greater increases ($Z = -2.62$, $P < 0.001$). Factors identified as causing stress during consultations included difficulties with communication, certain clinical presentations, and department organisational factors (particularly the intensity of workload).
Conclusions: Psychological distress is linked to confidence in senior house officers. This supports the need to monitor and build confidence in senior house officers and to address work related stressors. Additional communication skills training needs to be considered.

See editorial by Harris and Ferreira and pp 719, 740

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BMJ 1997;314:713–8

Introduction

Stress affecting junior doctors is receiving increasing attention.[1-8] It has been reported that excessive levels of stress may lead to dissatisfaction, lower morale, and poorer work performance.[5] Although it has been stated that there is a need to reduce excessive levels, little work has attempted to investigate relations between junior doctors' psychological distress levels and their clinical practice.

We looked at training needs of senior house officers in accident and emergency departments. Our initial aim was to investigate the relation between psychological distress and confidence in relation to a range of clinical and practical activities. Confidence was considered to be an important variable since it has been shown to be a subjective marker of competence and to be one component of the ability to function competently.[9] We also set out to report on areas where senior house officers have least confidence and to identify the occupational factors that cause greatest stress.

Methods

All 28 accident and emergency departments in the South Thames region were invited to participate in the study. All newly appointed senior house officers employed between August 1994 and February 1995

Table 1 Senior house officers' confidence related to clinical activities or topics with median confidence scores were ⩽50 (possible maximum 100) at the end of first month of accident and emergency training. Values are median (interquartile range) unless otherwise stated

Clinical area or problem	No of respondents	Month 1	Month 4	Z score	P value
Obstetrics and gynaecology	105	50.0 (36.0-69.0)	59.0 (47.8-71.5)	–3.68	0.001
Health needs of homeless	105	50.0 (33.0-60.0)	50.5 (36.0-65.3)	–2.44	0.01
Consulting with confused or abusive patients	105	50.0 (32.0-65.0)	50.0 (32.8-66.0)	–0.41	>0.05
Psychiatric problems	105	50.0 (34.0-60.0)	50.0 (40.0-65.3)	–2.72	0.01
Patients' complex social problems	105	50.0 (40.0-68.0)	50.0 (34.8-66.3)	–0.28	>0.05
Primary care needs of children	101	47.0 (33.0-60.0)	51.5 (40.0-65.0)	–3.49	0.001
Eye problems	105	46.0 (30.0-63.0)	60.0 (45.8-70.0)	–5.03	0.001
Ear, nose, and throat conditions	105	45.0 (30.0-63.5)	53.0 (40.0-64.3)	–3.58	0.001
Ill defined problems	104	40.5 (30.0-54.0)	49.5 (34.0-60.0)	–2.63	0.01
Paediatric emergencies	101	40.0 (30.0-60.5)	56.5 (40.0-70.0)	–4.47	0.001
Inserting a central venous pressure line	103	40.0 (20.0-59.0)	40.0 (20.0-65.0)	–2.06	>0.05
Dermatology	105	36.0 (26.0-50.0)	40.0 (24.5-52.0)	–0.30	>0.05
Plastering	104	35.0 (20.0-60.0)	39.0 (21.5-61.0)	–1.42	>0.05
Intubation	103	34.5 (20.0-51.3)	34.0 (22.5-56.0)	–1.17	>0.05

were sent questionnaires to be completed on their first day and at the end of the first, fourth, and final months of their attachments. Instructions for all four questionnaires stated that all responses would remain totally confidential.

Measures

Confidence—The questionnaires sent at the end of the first and fourth months asked subjects to rate their level of confidence in performing a range of 35 clinical and practical activities on 100 mm visual analogue scales (0 = not at all confident, 100 = very confident). The items were selected to represent a cross section of the range of specialties, types of patient presentations, and technical procedures senior house officers may deal with in accident and emergency.

Psychological distress—All four questionnaire booklets included the psychological distress questionnaire, which was based on existing scales, excluding items that could be confounded by the nature of working as a senior house officer in the accident and emergency setting. The measure consists of 25 items (14 negatively worded and 11 positively worded): 21 items were modified from the mental health inventory[10] and four from the 28 item general health questionnaire.[11] Scoring is on a six point scale. For analysis scores were reversed for negatively worded items so that for all ratings 1 = lowest distress and 6 = highest distress. The overall mean score for all completed items was calculated for each subject.

Work related stressors—Questionnaires sent at the end of the first and fourth months asked subjects "at the end of each of your next three shifts" to describe the case presentations that had caused most difficulty. For each, they were asked to indicate whether difficulties were due to "stress and/or worry caused by the consultation" and if so, to describe what they found stressful or worrying. At the end of the fourth month subjects were also asked to report the main factors that had caused them to feel stressed at work over the past month.

Table 2 Senior house officers' confidence related to clinical activities or topics with median confidence scores were >50 (possible maximum 100) at the end of first month of accident and emergency training. Values are median (interquartile range) unless otherwise stated

Clinical area or problems	No of respondents	Month 1	Month 4	Z score	P value
Suturing	104	80.0 (68.5-86.5)	84.0 (76.8-91.0)	–3.90	0.001
Defibrillation	104	75.0 (56.0-81.0)	71.5 (64.8-88.0)	-1.97	>0.05
Protecting self from infection	103	74.0 (61.5-80.0)	77.0 (65.0-86.3)	–2.26	0.05
Intimate examinations	105	72.0 (60.0-80.0)	80.0 (66.0-86.5)	–3.55	0.001
Referral to on call teams	104	71.0 (60.0-80.0)	79.0 (69.0-90.0)	–3.74	0.001
Acute surgical	105	70.0 (60.0-80.0)	71.5 (64.8-80.0)	1.88	>0.05
Acute medical	105	70.0 (62.0-80.0)	75.5 (65.8-81.0)	–3.44	0.001
Reading electrocardiograms	103	70.0 (58.8-79.3)	72.0 (64.0-80.0)	–2.72	0.01
Breaking bad news	105	70.0 (50.0-79.0)	70.0 (56.0-80.0)	–0.29	>0.05
Explaining lack of diagnosis to patient	105	68.0 (51.0-79.0)	70.0 (60.0-81.0)	–2.67	0.01
Orthopaedics	105	65.0 (45.0-76.0)	71.5 (60.0-81.5)	–5.21	0.001
Talking about sex or relationship problems	105	65.0 (50.0-80.0)	70.0 (56.8-80.0)	–2.58	0.01
Interpreting *x* rays	104	65.5 (56.8-75.0)	71.0 (63.0-80.0)	4.50	0.001
Dying patients	105	63.0 (50.0-70.0)	63.5 (50.0-77.0)	–1.28	>0.05
Elderly patients	105	63.0 (52.0-71.0)	66.0 (57.0-72.0)	–1.08	>0.05
Referral to primary care or community	103	61.0 (50.0-75.0)	69.0 (50.5-80.0)	–2.21	0.05
Fracture dislocations	104	60.0 (33.5-70.0)	66.0 (50.0-80.0)	–6.12	0.001
Primary care problems	103	60.0 (50.0-70.0)	66.0 (51.0-74.0)	–2.41	>0.05
Resuscitation and major trauma	105	57.0 (40.0-70.0)	68.0 (50.0-79.0)	–5.26	0.001
Parasuicide or self mutilation	105	57.0 (48.0-70.0)	65.0 (52.0-75.0)	–3.88	0.001
Alcohol or drug related problems	105	55.5 (44.8-70.0)	59.0 (45.0-71.0)	–1.62	>0.05

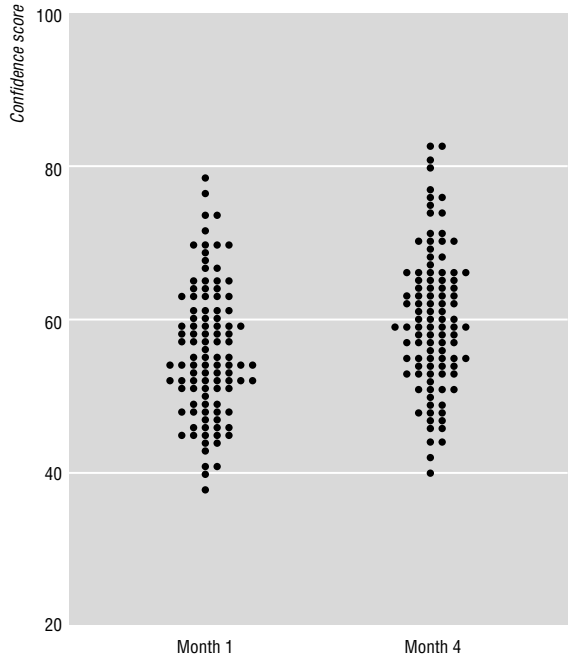

Fig 1 Overall confidence of 105 senior house officers in accident and emergency at end of months 1 and 4 (0=not at all confident, 100=very confident)

Personal stressors—In the final questionnaire subjects were asked to list all major stressful events that had occurred over the past six months.

Piloting

The first battery of questionnaires was administered to a separate sample of eight accident and emergency senior house officers in July 1994 to test for comprehensibility.

Analysis

Statistical analysis was carried out with the SPSS-X statistical package.[12] Confidence item scores at the end of months 1 and 4 were summed and the mean overall confidence score calculated. Wilcoxon matched pairs tests were used to investigate changes in confidence scores and psychological distress over time; Mann-Whitney U tests were used to analyse the relation between confidence and distress levels. The work related factors that caused subjects to feel stressed were analysed thematically and quantitatively according to the number of times issues were reported.[13] This procedure was repeated by an independent researcher to ensure reliability.

Results

The sample included 171 senior house officers from 27 sites; the mean age was 26.5 (range 23.7 to 35.7) years. The response rates to the questionnaires were 82% (140 respondents) at the start, 77% (132) at the end of the first month, 64% (110) at the end of the fourth month, and 67% (115) at the end of the sixth month.

Confidence over time

Figure 1 shows the distribution of overall confidence scores at the end of the first and fourth months for the 105 subjects completing both questionnaires. The median overall confidence score was 54.8 (range 37.8 to 78.5) at the end of month 1 and 59.7 (range 40.3 to 91.4) at the end of month 4. There was a significant increase in overall confidence ($Z = -6.05$, $P < 0.001$); the median change was 138.5 (range −507 to 1042). Men ($n = 65$) had significantly greater overall confidence than women ($n = 47$) at the end of the first month (median score 57.3 *v* 53.7; $Z = -2.32$, $P < 0.05$), but there was no significant sex difference at the end of the fourth month.

Tables 1 and 2 show the change in confidence scores between the end of the first and fourth month. Table 1 presents scores for the 14 items with median scores at or below 50 at the end of month 1, and table 2 shows the 21 items with median scores above 50 at the end of month 1.

Psychological distress

Figure 2 shows the distribution of scores on the psychological distress questionnaire at the start of the study, the end of the first month, and the end of the fourth month for the 97 subjects completing all three questionnaires. Distress levels did not differ significantly between these time periods. At the end of the first month, mean stress score had decreased 0.05 (SD 0.53; range −2.28 to 1.72) points; at the end of the fourth month the mean decrease was 0.05 (0.59; −1.96 to 2.12) in comparison with the start. Between the first and fourth months, mean distress score increased 0.04 (0.50; −1.84 to 1.72). The maximum change in distress scores for individual subjects was 2.28; standard deviations were between 0.5 and 0.59), indicating that for most subjects changes in distress scores were less than 1.0 during the study period.

Personal stressors

A total of 116 (76%) subjects reported experiencing no stressful personal life events during the first four months of the study. The remaining subjects experienced up to four stressful events such as death of a

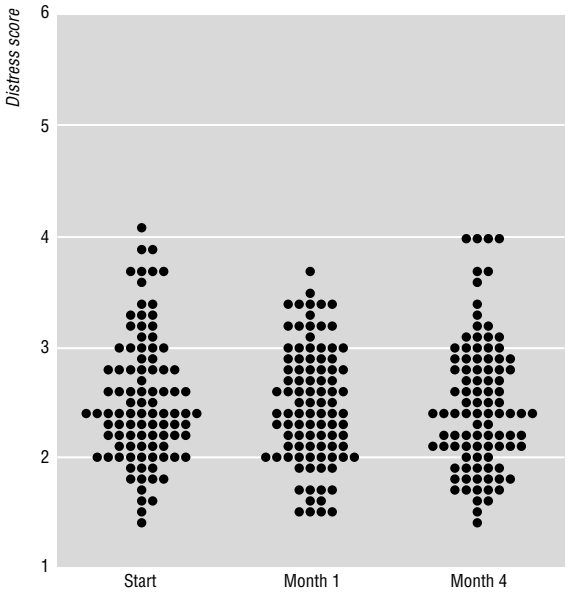

Fig 2 Stress scores of 97 senior house officers in accident and emergency at start of study and end of months 1 and 4 (1=lowest, 6=highest)

friend or relative, illness of a relative, divorce, relationship difficulties, personal injury, illness, taking exams, financial difficulties, and moving house.

Distress and confidence

When the sample was split at the median for overall confidence, subjects with lower confidence at the end of the first and fourth months showed significantly higher distress scores than those with higher confidence levels ($Z = -3.20$ ($P < 0.001$) *v* $Z = -1.90$ ($P < 0.05$; fig 3). When this analysis was repeated for subjects reporting no stressful life events the same results were found ($Z = -3.19$ ($P < 0.001$) *v* $Z = -1.90$ ($P < 0.05$)).

Subjects with change scores below the median had significantly higher psychological distress scores at the end of the fourth month than those with scores above the median ($Z = -2.62$ ($P < 0.01$); fig 4). The same results were found for the group reporting no stressful personal life events ($Z = -2.18$, $P < 0.05$).

Work related stressors

Of a possible total of 726, 586 (81%) case descriptions of consultations causing difficulty were completed. The factors reported as contributing to the difficulties encountered related to three broad categories: the type of problem presented by the patient, communication difficulties, and department organisational issues (box 1).

At the end of their fourth month subjects reported the main factors that caused them to feel stressed while working during the preceding four weeks (box 2). The most frequently reported stressors were related to department organisational factors, in particular the intensity of workload.

Discussion

Senior house officers with higher distress scores had significantly lower confidence in carrying out a range of clinical and practical tasks. Those with higher distress scores at the end of the fourth month also had significantly lower increases in confidence between the end of the first month and the end of the fourth month.

Despite the significant increase in senior house officers' confidence for carrying out a range of activities, confidence remained low in several areas. In particular, these related to certain technical skills (intubation, plastering, inserting a central venous pressure line) and managing patients with psychosocial problems (consulting with confused or abusive patients, dealing with patients' complex social prob-

Box 1—Factors causing senior house officers stress during 586 "difficult" consultations

Consultation factors

Type of clinical presentation (91; 16%)
Paediatrics (36)
Dead or dying patients (10)
Psychiatric patients (10)
Road traffic accident or acute multiple trauma (7)
Patient in pain (5)
Trivial condition (5)
Cardiac problems or arrest (4)
Head injuries (4)
Eye injuries (2)
Drug addicts or overdose cases (2)
Patient alcoholic (2)
Pregnancy (1)
Bowel obstruction (1)
Cervical spine injuries (1)
Problems entirely social (1)

Assessment (38; 6%)
Unable to/whether to admit patient (12)
Lack of confidence in own skills (11)
No pathology detected (7)
Problems assessing patient (4)
Concern about risk of contracting disease (2)
Embarrassment on examining patient (1)
Lack of experience (1)

Diagnosis (87; 15%)
Concern about missed or incorrect diagnosis (87)

Treatment (9; 2%)
Lack of experience (7)
Poor response to treatment (2)

Communication with patient or relatives (132; 23%)
Dealing with demanding, manipulative, violent, or aggressive patients (50)
Dealing with family or friends; breaking bad news (34)
Poor historian or unwilling to provide history (15)
Uncooperative patient (15)
Patient disagreed with SHO's opinion (11)
Other (6)
Racism among patients (1)

Personal concerns

Concern about medicolegal issues (15; 3%)
Medicolegal worries or threat of being sued (5)
Patient complained (5)
Restraining orders (4)
Legal implications of withholding information from police (1)

SHOs' own feelings of stress or distress (18; 3%)
Own anger or frustration (10)
Feeling of lack of authority or control (3)
Seeing aborted fetus (1)
Seeing decapitated body (1)
Unable to stay calm (1)
Made to feel guilty by patient (1)
Feeling sad or upset (1)

Organisational factors

Discharge or referral (74;13%)
Discharging patient; concern about future problems (31)
Problems with referral/when to refer (27)
No GP or problem with GP (4)

Medical/nursing team (20; 4%)
Problems with other teams; colleagues reluctant to see or admit patients (6)
Arguing with colleagues or nursing staff (4)
Had to disturb a colleague (2)
Lack of guidance from specialist teams (2)
Had to ask colleague for help (1)
Failure to do something urgently (1)
Racism among staff (1)

Departmental issues (33; 6%)
Unable to treat patient; treatment not available on site (10)
Night consultations or disturbed sleep (7)
Fears for safety; no security in department (6)
Busy department (5)
Bed shortage (3)
Problems with defibrillating equipment (1)
Waiting for results (1)

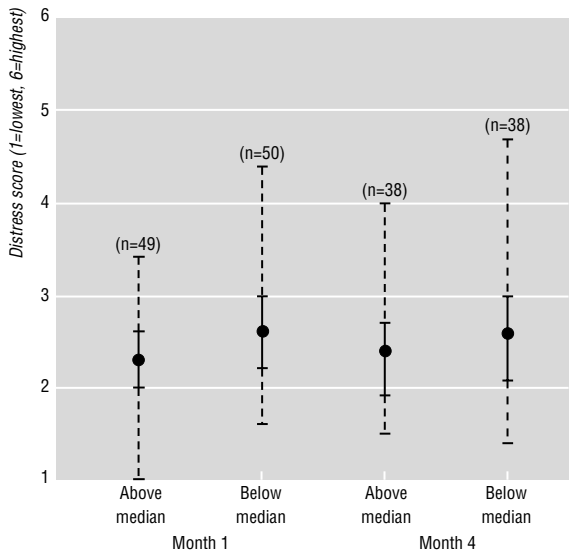

Fig 3 Psychological distress scores of senior house officers with confidence below or above mean (P<0.001 at month 1, P<0.05 at month 4, Mann-Whitney U test)

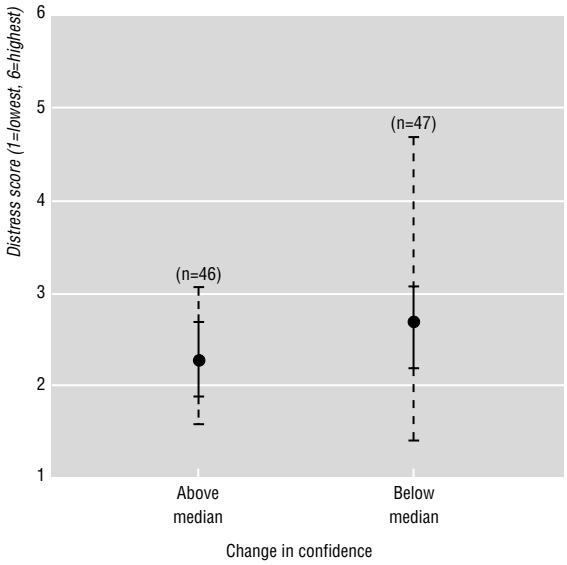

Fig 4 Psychological distress scores of senior house officers with change in confidence below or above median at end of fourth month (P<0.01, Mann-Whitney U test)

lems, psychiatric problems). Confidence was higher for managing patients with trauma or acute medical or surgical needs, reflecting the emphasis in undergraduate training and preregistration house jobs.

A wide range of consultation problems, departmental organisational factors, and personal concerns were reported as stressors. Communication difficulties (dealing with demanding, manipulative, violent, or aggressive patients) were frequently cited. This suggests that training in communication skills may be beneficial. In a recent study of burnout and psychiatric disorder among hospital consultants Ramirez and colleagues found that clinicians who felt insufficiently trained in communication skills had significantly higher levels of distress.[14] This finding may also apply in the early stages of medical careers. Training sessions in communication skills could provide the opportunity for case review.

In terms of factors causing most stress overall, the intensity of workload, coping with diagnostic uncertainty, working alone, working unsocial hours, and experiencing fatigue emerged as key stressors. This is consistent with other studies of junior hospital doctors,[1 15] general practitioners,[16] and cancer clinicians.[17]

Methodological considerations

The psychological distress questionnaire was developed from the mental health inventory[10] and the general health questionnaire[11] because existing scales included items that could be confounded by the nature

Box 2—Main factors causing stress to 100 senior house officers during their fourth month working in accident and emergency

Consultation factors

Patient factors (24%)
Violent, abusive, or demanding patients (16)
Trivial conditions (5)
Patients or relatives disagreeing with diagnosis or treatment plans (1)
Repeat attenders (1)
Breaking bad news (1)

Clinical presentation (17%)
Treating paediatric patients (5)
Drug or alcohol dependent patients (2)
Making mistakes (2)
Elderly patients (2)
Seriously ill patients (1)
Cervical spine injuries (1)
Multiple trauma patients (1)
Deliberate self harm (1)
Primary care patients unhappy with GP (1)
Resuscitation(1)

Personal concerns (4%)
Personal problems (2)
Low morale (1)
Lack of a challenge (1)

Organisational factors

Workload (73%)
Intensity of workload (33)
Alone working nights; poor support from seniors (10)
Fatigue; lack of sleep (8)
Working alone; lack of support (6)
Lack of time off (6)
Unsociable rota (6)
Working for examinations (2)
Working nights after annual leave (1)
Feeling isolated (1)

Staff factors (19%)
Difficulty referring to specialties (8)
Tensions between staff (4)
Lazy colleagues (2)
Lack of supervision or teaching (1)
Violent nurses (1)
Having to refer to busy colleagues (1)
Difficulty in getting teams to review (1)
No paediatric cover (1)

Disposal (7%)
Bed shortages (6)
Uncertain when to refer or admit (1)

Key messages

- The importance of dealing with stress in junior doctors has been emphasised since excessive levels of stress may lead to dissatisfaction, lower morale, and poorer work performance
- Senior house officers' psychological distress levels is inversely related to their confidence in carrying out a range of clinical tasks in accident and emergency
- Intensity of workload, communication difficulties, and feeling concerned about incorrect or missed diagnoses were common stress factors
- Senior house officers may benefit from training in communication skills
- There remains a need to reduce high work intensity and provide greater support

of working as a senior house officer in accident and emergency. The aim of our study was not to describe psychiatric morbidity but rather to investigate how far psychological distress was associated with confidence levels. The distress questionnaire and confidence rating scale have not been tested for reliability and validity, and there was no control for the potential problem of reactivity in terms of biased response sets. Nevertheless, the distress and confidence scores show that all subjects' scores do not change in the same direction over time. The small number of senior house officers working at each site prevented investigating the extent to which confidence scores, distress scores, and stressors related to departmental features.

Conclusions

In senior house officers in accident and emergency departments, there seems to be an inverse relation between psychological distress and confidence in performing tasks. Future studies are required to establish if there is a causal link, the direction of causality, and to investigate the relation between senior house officers' confidence and their clinical competence. Our study indicates some work related stressors that need to be considered. Although training in communication skills may be beneficial,[18] the problems of high work intensity for senior house officers and inadequate senior cover during nights need to be addressed. As stated recently, emergency medical care should not be provided by doctors who are chronically short of sleep or who have not had adequate rest periods during shifts.[19]

The assessment of confidence, distress levels, and work related stressors would enable training and support to be tailored to individual needs. With the increasing numbers of middle grade and multiconsultant departments, new support initiatives for senior house officers should be considered. Future work is required to establish whether these findings also apply to junior medical staff working in other specialties.

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Conflict of interest: None.

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ONE HUNDRED YEARS AGO

Surgeons in the pulpit

One of the Liverpool clergy has just suggested that hospital sermons should be preached, not by his own brethren, but by medical men. This is a terrible idea, and we hope it will go no further: for it is capable of extension. Military men might preach in time of war; artists and musicians might plead for the opening of museums and concert-rooms on Sunday; secretaries of charitable institutions would want to preach at least once a year; and the clergy would soon have only the week days left to them. Their congregations would be first amused, then scandalised, then dispersed.

We question whether the more self-respecting members of hospital staffs would accept the duty. It is said that there are four things which we all believe we can do better than somebody else: poking the fire, finding a train in *Bradshaw*, deciphering a word in an ill-written letter, and preaching a sermon. As to the first three, offers of interference are common enough; but the suggestion that we should not only practise what we preach, but should also preach what we practise, is too tiresome for serious consideration. (*BMJ* 1897;i:356.)

Senior house officer training: is it getting better? A questionnaire survey

Elisabeth Paice, Georgina West, Ruth Cooper, Victor Orton, Alastair Scotland

A survey of senior house officer posts in North East Thames region uncovered problems with workload, supervision, and education[1 2] similar to those described by others.[3] During the following years two important stages in the implementation of the "New Deal" on junior doctors' hours[4] were achieved. After two years we revisited the hospitals surveyed to discover what progress had been made and whether shorter working hours had affected training.

Methods and results

The first survey (1992-3 to 1993-4) was carried out by the associate dean, who visited all 19 acute hospitals and three specialist hospitals in North East Thames region and interviewed as many senior house officers as available. Before the interview trainees completed a structured questionnaire. Postal questionnaires were distributed to those doctors unavailable on the day. In 1994-5 we repeated the survey, using the same method, in all 11 hospitals visited during 1992-3. These included nine district general hospitals, one psychiatric hospital, and one large multisite university teaching hospital. The survey was not extended to hospitals visited in 1993-4 because many New Deal changes were taking place during this year.

In 1992-3 we surveyed 270 senior house officers, 216 (80%) by questionnaire and interview, 54 (20%) by postal questionnaire. In 1994-5 we surveyed 361, 249 (69%) by questionnaire and interview, 112 (31%) by postal questionnaire. The larger number in the second survey reflected a better response to the postal questionnaires and an increase in the total number of senior house officers. The response rate based on the total number of posts was 270/519 (52%) for the first round and 361/582 (62%) for the second. However, at any time at least 15% of the doctors were on leave and at least 15% of posts were vacant. We excluded locums or trainees less than two weeks in post. Corrected for 30% unavailability, response rates were respectively 270/363 (74%) and 361/407 (89%). The proportion of respondents from each specialty was similar on each occasion, apart from paediatrics and obstetrics and gynaecology, where new posts were created between the surveys. The proportion of non-British graduates rose from 32% to 44%.

Table 1 shows an improvement in senior house officers' rating of their posts between the two periods. The specialties showing most improvement were paediatrics and obstetrics and gynaecology, the worst rated specialties in the first survey, where new posts had enabled more partial shift working. The only specialty with lower ratings in the second survey than in the first was accident and emergency, where senior house officers were less likely to recommend their post. Non-British graduates were less likely to feel forced to cope beyond their competence, but did not differ otherwise from British graduates in their responses.[5] Both interview and postal respondents showed improvement between the two surveys.

Comment

The reasons for the improvement are speculative. The implementation of the New Deal may have contributed, particularly over intensity of work. In September 1992 over 60% of senior house officers in these 11 hospitals were contracted for over 72 hours for on call rotas or 56 hours for full shifts. By February 1995 the figure had dropped to under 1%. Over £870 000 was spent by the New Deal task force in these hospitals to

Table 1 Senior house officers' responses in 1992-3 and 1994-5

	No (%) of senior house officers	
Questions and responses	**1992-3 (n=270)**	**1994-5 (n=361)**
How would you rate the intensity of work in your post?		
Too light	9 (3.3)	2 (0.6)
Light	12 (4.4)	12 (3.3)
Satisfactory	110 (41)	211 (59)
Heavy	85 (32)	117 (32)
Excessive	53 (20)	18 (5.0)
Not answered	1	1
How often do you feel forced to cope with problems beyond your experience or competence?		
All the time	18 (6.7)	0
Once or twice daily	42 (16)	6 (1.7)
Once or twice weekly	47 (17)	42 (12)
Once or twice monthly	75 (28)	166 (46)
Never	76 (28)	143 (40)
Not answered	12	4
How would you rate your consultant supervision?		
Very poor	28 (10)	6 (1.7)
Poor	33 (12)	35 (9.7)
Adequate	70 (26)	97 (27)
Good	64 (24)	138 (38)
Excellent	64 (24)	83 (23)
Not answered	11	2
Have you sat down with your consultant to discuss your progress?		
No, but I would have liked to	107 (40)	64 (18)
No, but it was not necessary	10 (3.7)	24 (6.6)
No, but it will happen	15 (5.6)	47 (13)
Yes, but it was not useful	19 (7.0)	14 (3.9)
Yes, and it was useful	51 (19)	158 (44)
No, but not in post 3 months	68	54
How many hours a week of formal education do you get to each week?		
0-1 hours	77 (29)	73 (20)
2 hours	75 (28)	121 (34)
3 hours	54 (20)	91 (25)
4 hours	33 (12)	55 (15)
5 or more hours	30 (11)	20 (5.5)
Not answered	1	1
How would you describe your post to a friend who was thinking of applying?		
Very poor	23 (8.5)	8 (2.2)
Poor	53 (20)	33 (9.1)
Adequate	68 (25)	104 (29)
Good	80 (30)	170 (47)
Excellent	40 (15)	36 (10)
Not answered	6	10

See editorial by Harris and Ferreira and pp 713, 740

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reduce non-medical duties for junior doctors, fund 15 new consultant posts, and upgrade accommodation. Approval was given for 66 extra senior house officer posts (a 12.5% increase). Other factors include greater pressure from colleges, part funding of posts by the postgraduate dean, and setting of regional training standards for senior house officers.[2] The surveys themselves may have raised consultants' awareness of the problems and of their responsibilities as educational supervisors.

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Increased parity and risk of trisomy 21: review of 37 110 live births

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Routine amniocentesis for all women over the age of 35 for detecting trisomy 21 has been the world standard for nearly two decades. It is based on a calculated tradeoff: the documented increased risk of trisomy 21 with advancing age versus the risk of fetal loss secondary to the amniocentesis procedure.

Recent data suggest that more specific individual estimates of risk can be made with a combination of maternal age and serum markers.[1] We have reported a trend towards an increased risk of trisomy 21 with increased parity.[2] Given the uniqueness of our population—ultra-Orthodox Jewish mothers who have a high rate of delivery over the age of 35, high parity, and who abstain from prenatal screening and abortion—we had an opportunity to study the interrelation of age and parity.

Patients, methods, and results

We reviewed all deliveries at the Shaare Zedek Medical Center in 1981-9, the period before α fetoprotein and ultrasound screening for the prenatal detection of trisomy 21 became available in Israel. All clinically suspected cases of Down's syndrome were cytogenetically confirmed as trisomy 21. Mothers were analysed by five year age groups and further subdivided by parity as primiparous, multiparous (second to fifth delivery), and grand multiparous (sixth delivery or more). Statistical comparison between groups was by Poisson distribution analysis. The attributable risk of parity was calculated by a standard formula.[3]

In 37 110 live births, trisomy 21 was diagnosed in 54 infants, resulting in an overall incidence of 1.46 per 1000 live births (1:687 live births). Table 1 shows the rate of trisomy 21 in each five year age group and the prevalence of trisomy 21 in each age group by parity. Grand multiparity was associated with an increased prevalence in the age groups between 25 and 44 ($P<0.005$ for ages 25-29, $P<0.08$ for ages 30-34, $P<0.001$ for ages 40-44), and prevalence was higher in multiparous women than in primiparous women in all age groups. In the 40-44 age group, prevalence was significantly higher with grand multiparity than multiparity ($P<0.001$). In the 20-24 age group, prevalence of trisomy 21 was significantly higher for multiparous mothers than for primiparous women and for the average rate of this group ($P<0.05$). The attributable risk of parity to the birth of an infant with trisomy 21 was calculated to be 15%.

Table 1 Prevalence of trisomy 21 at Shaare Zedek Medical Center, Israel, 1981-9. Values are rate (per 1000 live births) and ratio, unless specified otherwise

Age (years)	No of live births	No with trisomy 21	Rate (ratio)	Parity		
				1 (n=9630)	2-5 (n=21 765)	⩾6 (n=5715)
<20	842	0	0 (n=832)	0 (0:732)	0 (n=110)	
20-24	10 879	8	0.7 (1:1360)	0.4 (1:2751)	1.1 (1:892)¶	0.0 (n=25)
25-29	12 010	7	0.6 (1:1716)	0 (n=2186)	0.7 (1:1516)	1.4 (1:728)*
30-34	8 259	11	1.3 (1:750)	0 (n=792)	1.2 (1:847)	2.1 (1:477)†
35-39	4 171	8	1.9 (1:512)	0 (n=345)	2.2 (1:461)	2.0 (1:496)
40-44	902	16	17.7 (1:56)	0 (n=69)	3.8 (1:260)	26.2 (1:38)‡§
⩾45	47	4	85.1 (1:12)	0 (n=3)	0 (n=10)	120 (1:9)
Total	37 110	54	1.46 (1:687)	0.2 (1:4815)	11 (1:946)	50 (1:197)

*P<0.005, grand multiparity *v* all parity.
†P<0.08, grand multiparity *v* all parity.
‡P<0.001, grand multiparity *v* all parity.
§P<0.001, grand multiparity *v* multiparity.
¶P<0.05, multiparity *v* all parity.

Comment

In the past five years the reliance on maternal age alone as an indication for amniocentesis for detecting fetal trisomy 21 has been modified by the use of multiple maternal serum markers.[4] Our data show that parity can be used to help identify mothers under 35 at high risk and mothers over 35 at low risk.

Because the relatively small size of our sample (37 110 deliveries and 54 infants with trisomy 21) precluded analysis in each yearly age cohort group and for each parity level, the analysis was performed for 5 year age groups and by conventional categories of parity. In almost all age groups with enough grand multiparous mothers for a valid calculation, these groups had a significantly higher rate of trisomy 21 than did all the mothers in the group. A ratio of 1:38 in the grand multiparity 40-44 age group and the absence of any infants with trisomy in 4299 primiparous women aged 25-40 strongly suggests an interrelation between age

and parity, calculated to be 15% greater than from age related factors alone.

Other, much smaller studies do not necessarily support our data.[5] Further population studies are needed to provide a large database for exact calculations that will provide a basis for public health recommendations and guidelines for individual families.

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Commentary: Down's syndrome and parity

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Everyone knows that the risk of Down's syndrome rises with the mother's age. Parity also rises with age. Could some of the increased risk among older mothers be accounted for by their greater mean parity?

Schimmel and colleagues found the expected sharp rise in risk of Down's syndrome with maternal age, but they also found an independent effect of parity—at a given age, risk rose with parity. They say that parity might be an additional factor to be taken into account in the calculation of the risk of Down's syndrome. Before accepting this conclusion, we need to ask ourselves whether the data may be confounded in some way.

The data were derived from 37 110 births which occurred during 1981-9 at the Shaare Zedek Hospital. The authors defend the measurement of birth prevalence as a proxy for incidence (terminations and births) on the grounds that this institution serves an exclusively orthodox Jewish population who eschew prenatal diagnosis. But some women may have availed themselves of prenatal diagnostic services elsewhere. If this were true, and if they tended to be of lower parity (perhaps because they were also less averse to contraception), then this would bias the results towards greater risk at high parity. However, this effect would apply almost exclusively to older women, since only maternal age screening was available for Down's syndrome in Israel before 1990. The "parity effect" was indeed greatest among such women, but it was also present among younger women. Therefore, although this form of bias is supported by the data, it cannot fully explain the observed association.

Maternal age was grouped in five year age bands. This can lead to "truncation," a spurious or exaggerated association between two variables when they increase at different rates across the band range in the control variable.[1] In this case, both risk of Down's and parity systematically favour the high end of each maternal age band, but Down's risk increases exponentially. Modelling would show how much of the additional risk attributed to parity could plausibly be ascribed to this problem. However, this bias would affect older mothers in particular, since the risk of Down's syndrome increases rapidly across the higher age bands. Again, therefore, the association among younger mothers cannot be attributed solely to this bias.

The authors do not attempt to embed their results in a systematic review; they do not quote such a review, and they quote only one other paper, whose findings were negative.[2] Castilla and Paz duplicated the Israeli analysis, and when five year age bands were used they also found an association between parity and risk of Down's syndrome—but this association was confined to the oldest age bands.[3] Furthermore, mean maternal ages (within bands) were significantly higher for mothers of infants with Down's syndrome than for control mothers. Thus, truncation may have "explained" the findings, at least in part.

Lastly, the Israeli paper showed a startlingly low prevalence of Down's syndrome among primiparous women—no cases in 4299 births to mothers aged 25-40. Associations based on atypically low risks in control populations call for wariness.

If the association were true, what is the mechanism? It is hard to imagine that parity or high fertility predisposes to non-disjunction, and translocation carriers should be predisposed to high gravidity rather than parity (H Cuckle, personal communication). The most plausible hypothesis that I can think of is that parous women are less likely to abort not only normal fetuses but also those with aneupoidy. Before we investigate this further or advise women to take parity into account, corroboration of the main findings is required.

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Correction

Retrospective study of reasons for improved survival in patients with breast cancer in East Anglia: earlier diagnosis or better treatment?

An editorial error occurred in this paper by Diane Stockton and others (15 February, pp 472-5). Figures 1 and 2, but not their legends, were transposed. Thus the figure on p 474 is figure 1 (legend on p 473) and the figure on p 473 is figure 2 (legend on p 474).