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The epidemiology of inguinal hernia

A survey in western Jerusalem

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SUMMARY The epidemiology of inguinal hernia was investigated in a community survey in a neighbourhood of western Jerusalem in 1969-71. The current prevalence rate, excluding operated hernias, was 18 per 100 men aged 25 and over, and the lifetime prevalence, including operated hernias, was 24 per 100. Prevalence rose markedly with age; the lifetime prevalence rate reached 40 per 100 men at the ages of 65-74 and 47 per 100 at 75 and over. The prevalence of hernia was significantly higher in the presence of varicose veins, in men who reported symptoms of prostatic hypertrophy, and, among lean men only, in the presence of haemorrhoids. These associations may reflect the role of increased abdominal pressure. The prevalence of hernia was low in the presence of overweight or adiposity, suggesting that obesity is a protective factor. No significant age-independent associations were found with chronic cough, constipation, physical activity at work, or a number of other variables. Two-thirds of the hernias had not been operated upon. The prevalence of unrepaired hernias rose with age; 13% of all men aged 65-74 and 23% of those aged 75 and over had unoperated groin swellings. One in every five operated hernias showed evidence of recurrence. No significant age-independent associations were found between evidence of recurrence and other characteristics. A comparison of interview responses and examination findings showed that interview data on the presence of hernias were of low validity, mainly because of under-reporting.

A multipurpose community health survey conducted in a neighbourhood of western Jerusalem in 1969-71 (Kark *et al.*, 1970) provided an opportunity to study the epidemiology of inguinal hernia. Knowledge of the epidemiology of this common condition is scanty.

The main aims of the study were to investigate the prevalence and correlates of inguinal hernia among men in this population. We also measured the extent of surgical intervention and the number of recurrences, and tested the validity of interview data on the presence of hernia.

Methods

The survey was conducted by the Department of Social Medicine of the Hebrew University-Hadassah Medical School and Hadassah University Hospital in a neighbourhood established in the early 1950s to house new immigrants from more than 25 countries.

The population in 1969-71 was therefore heterogeneous in origin: 35% of men were immigrants from Europe (mainly central or eastern) and America; 17% came from countries in Asia (predominantly the Middle East); and 16% from north Africa (especially Morocco). The remaining 32% were born in Israel. The population was also heterogeneous in social class (SC) and educational level. An adaptation of the Registrar-General's classification placed 14% of men in SC I, 18% in SC II, 50% in SC III, and 13% in SC IV-V. Five per cent were unclassifiable. Few men (4%) had had less than five years of schooling; 24% had had

five to eight years, 41% had studied for nine to twelve years, and 31% had had thirteen or more years of education. Almost all were Jewish.

The study population originally included all male residents aged 20 or over and a 50% probability sample of those aged 15-19. The investigation comprised an interview at the subject's home and a subsequent examination by a doctor at the department's community health centre. The response rate for interviews among men aged 25 or over was 86%. At younger ages the response rates were low, 60% at 15-19 years and 68% at 20-24 years; this was largely due to absence from the area, mainly because of army service. Because of possible sample bias at ages 15-24, the analysis of hernias was confined to men aged 25 or over (1883 men aged 25 years or over were examined who consisted of 91% of the men in this age range who had been interviewed and who were 78% of the total male residents).

Special attention was paid to standardising techniques, including the careful training and supervision of interviewers and examiners and the use of standardised questions, examination procedures, and diagnostic criteria. The home interview included a question on the occurrence of hernia past or present. If it was answered positively, the man was asked if he had ever had an operation for hernia. The examining physician was informed of the replies.

The examination procedure was the one described by Bailey (1942). The examining physician reported whether, in each groin, there was a visible and clearly palpable hernia (such hernias will be referred to below as 'swellings'); a palpable impulse (a clearly detectable impulse at the external inguinal ring on coughing, in the absence of a 'swelling'); or an operation scar. The examination was conducted with the subject standing in a good light. After inspection, any visible lump was palpated to determine whether it was possible to 'get above it' with the thumb and index finger. If not, and if its neck was continuous with the inguinal canal or directed backwards into the abdomen, it was diagnosed as a palpable hernia (a 'swelling'). If there was no visible lump, the scrotum was invaginated by the little finger to reach the external ring, and the subject was asked to cough, in order to determine whether there was a palpable impulse. An impulse at the scar site on coughing was taken as evidence of recurrence. No attempt was made to distinguish between indirect and direct hernias. 'Swellings' and repaired hernias (that is, excluding palpable impulses) will be referred to below as 'obvious' hernias.

We studied associations between hernia and a number of other disorders and characteristics, using data from the interview and examination. The interview included questions on respiratory symptoms—using the short questionnaire of the Medical Research Council (1960)—urinary symptoms, haemorrhoids diagnosed by a physician ('Have you ever had piles—that is, haemorrhoids? Did a doctor say so')?, the frequency of bowel movements, constipation ('Do you frequently have constipation?'), and the occurrence of low back pain. The diagnosis of chronic bronchitis was based on the presence of cough and phlegm (Higgins, 1957) in the absence of clinical evidence of other causes. Probable prostatic hypertrophy was diagnosed if at least three out of the following five symptoms were reported: frequency (often urinates more than once an hour); nocturia (usually gets up more than once a night); hesitancy (usually); stream much weaker or slower than previously; and terminal dribbling for half a minute or more. The presence of varicose veins was determined by clinical examination with the subject standing. A record was made of the presence of clearly visible distended and tortuous veins in the lower limbs; small subcutaneous venectasias were not included. Five indices of adiposity and weight-for-height were used: relative weight (percentage of the mean weight of men aged 25 of the same height, according to US medicoactuarial tables (Interdepartmental Committee for Nutrition in National Defense, 1963); Quetelet's index (weight/height^2); and suprailiac, triceps, and subscapular skinfold measurements. The right mid-arm muscle circumference (Jelliffe, 1966) was taken as a measure of muscularity. We used three indices of physical activity at work: a score based on the reported performance of various activities, a modification of the HIP index (Shapiro *et al.*, 1965); the reported frequency of lifting or carrying; and an index based on the type of occupation (Morris and Crawford, 1958).

Associations between hernia and other characteristics were initially examined by classifying the men according to these other characteristics and comparing the age-standardised prevalence rates of hernia in the various groups, using the total group of examined men as the standard population. In the initial statistical tests of these associations, the strength of associations was measured by a mean odds ratio or 'relative risk' computed by weighting the findings in separate age groups; their statistical significance was measured by summary χ^2 tests (Mantel and Haenszel, 1959).

Subsequently analysis of variance was performed, using the ANOVA subprogram classic experimental approach of the Statistical Package for the Social Sciences (SPSS) (Nie *et al.*, 1975). In this way each association was examined while adjusting for effects connected with all other factors included in the analysis; statistical significance was estimated from χ^2 values derived from the sum of squares (Gabriel, 1963).

Results

There were 459 men with inguinal hernias who between them had 637 hernias. The prevalence of men with hernias per 100 men in each decade of age is shown in Table 1. Separate rates are shown for current prevalence (excluding successfully repaired hernias) and lifetime prevalence (including such repairs). The current prevalence rate was 18 per 100 men. It rose from 12% at ages 25-34, to 29% at 65-74, and to 34% in the small group of men aged 75 and over. At younger ages the hernia usually took the form of a palpable impulse, and relatively few men had visible swellings; there were few older men with palpable impulses only. The proportion of men with unoperated swellings rose with age, reaching 13% at ages 65-74 and 23% at 75 and over. The proportion with evidence of recurrence rose to 6% in the higher age groups.

The lifetime prevalence rate was 24 per 100 men. It rose from 15% at ages 25-34, to 40% at 65-74, and to 47% at 75 and over.

An analysis of the characteristics of the hernias shows that with advancing age there was a marked increase in the proportion of 'obvious' hernias (Table 2). One-third (34%) of all hernias or two-thirds (64%) of 'obvious' ones had been operated upon. The proportion operated upon rose from 22% of all hernias at ages 25-34 to 40% at 45-54, and remained unchanged above this age. One in every five of all operated hernias showed evidence of recurrence and from the age of 45 this was one in every four.

Among persons with operated hernias, the proportion of men with evidence of recurrence rose with age; this proportion was 14% (of 56 men) at ages 25-44, 23% (of 92) at 45-64, and 30% (of 39) at 65 or over.

If repaired hernias were included, 179 (39%) of men with hernias had bilateral hernias. This percentage rose from 31% at ages 25-34, to 45% at 65-74, and to 59% at 75 or over. In 40% of men with hernias the hernia was on the right only, and in 21% it was on the left only. Fifty-seven per cent of all hernias (and the same percentage of all 'obvious' hernias) were on the right, and 43% on the left giving a right-left ratio of 1·3 : 1.

Associated characteristics

After adjustment for age, the prevalence of hernia was significantly related to six variables (Table 3). The rate was relatively high in the presence of varicose veins, prostatic hypertrophy, and haemorrhoids; it was relatively low in the presence of overweight or adiposity as measured by relative weight, Quetelet's index, or the suprailiac skinfold thickness. Other skinfold measurements (triceps and subscapular) showed similar trends, but they were not statistically significant.

Table 1 *Number of men with inguinal hernia per 100 men, by age*

	Age (years)						
	25-34	*35-44*	*45-54*	*55-64*	*65-74*	*75+*	*Total*
No. of men examined	620	438	300	322	156	47	1883
Current prevalence (excluding successful repairs)	11·9	15·1	19·7	26·1	29·5	34·1	18·3
'Obvious' hernias*	1·0	4·8	9·0	14·3	19·2	29·8	7·6
Unoperated swellings	0·7	3·7	5·7	10·9	13·5	23·4	5·5
Recurrences	0·3	1·4	3·7	3·4	5·8	6·4	2·2
Palpable impulse only	11·0	10·3	10·7	11·8	10·3	4·3	10·7
Lifetime prevalence (including successful repairs)	15·2	19·4	28·0	34·5	39·7	46·8	24·3
'Obvious' hernias	4·7	9·6	18·3	24·2	30·8	44·7	14·5

*The prevalence of all 'obvious' hernias may be less than the combined prevalences of unoperated swellings and recurrences, since the same person may have an unoperated swelling in one groin and a recurrence in the other.

Table 2 *Characteristics of inguinal hernias: percentage distribution by age*

	Age (years)						
	25-34	*35-44*	*45-54*	*55-64*	*65-74*	*75+*	*Total*
No. of hernias (100%)	123	115	115	159	90	35	637
'Obvious' hernias							
Unoperated swellings (%)	4	16	16	26	30	46	20
Repaired, without recurrence (%)	20	23	30	30	32	31	27
Repaired, with recurrence (%)	2	6	10	9	10	9	7
Palpable impulse (%)	74	55	44	36	28	14	46

Table 3 *Relationships between prevalence of inguinal hernia and six variables, adjusted for age**

Variable	*No. of men*	*Age-standardised lifetime prevalence rate (%)*	*Relative risk†*	P‡
Varicose veins				
Absent	1628	22·7		
Present	245	34·0	1·7	0·0006
Probable prostatic hypertrophy				
Absent	1712	23·6		
Present	194	32·1	1·6	0·01
Reported haemorrhoids				
Absent	1360	22·9		
Present	516	27·6	1·3	0·046
Relative weight				
<100%	481	27·7		
100-109%	868	25·4	0·7	0·006
110-119%	447	25·9		
120%+	389	19·8		
Quetelet's index				
<0·23	447	27·6		
0·23-0·25	660	24·0	0·7	0·01
0·26-0·27	361	26·5		
0·28+	376	19·3		
Suprailiac skinfold (mm)				
<10	272	30·2		
10-14	394	26·1		
15-19	435	22·2	0·7	0·008
20-29	538	22·0		
30+	199	22·5		

*The rates and statistical indices are adjusted for age (see page 60).
†The estimated relative risk associated with the specified condition, with a relative weight of 120%+, with a Quetelet's index of 0·28+, or with a suprailiac skinfold of 15 mm or more.
‡Significance of the difference of the relative risk from unity.

No significant relationships independent of age were found with region of birth, social class, years of education, consanguinity of parents, physical activity at work, chronic bronchitis, chronic cough, constipation, the frequency of bowel movements, low back pain, or arm muscle circumference.

Those factors found to be significantly related to hernia were examined by analysis of variance, looking first at inguinal hernia as a whole and then at 'obvious' hernias. The method we used expresses only the specific effect of each factor over and above what can be explained by the other factors examined. The specific effects of factors strongly associated with one another may thus be small even when their combined additive effect is large. For this reason we included only one measure of obesity—namely relative weight—in the analyses shown in Table 4. In an analysis where both relative weight and suprailiac skinfold thickness were included, neither was significantly associated with hernia, although their combined effect was highly significant.

As the left-hand section of Table 4 shows, all hernias were significantly associated with age, varicose veins, and relative weight. The relationships with prostatic hypertrophy and haemorrhoids were somewhat short of significance. All five variables together accounted for only 6% of the total variance.

There were two noteworthy interactions, suggesting nonconsistent relationships with hernia—that is, relationships which were different in different categories of the study population. Firstly, there was a significant interaction between haemorrhoids and relative weight. A cross tabulation showed that age adjusted hernia was significantly associated with haemorrhoids only among men whose relative weight was below 100% (relative risk = 2·4; P = 0·0006); there was no such association among those with relative weights of 100-119% (relative risk = 1·1) or 120% and above (relative risk = 0·9). The negative association between a high relative weight (120%+) and hernia was stronger among men with haemorrhoids (relative risk = 0·5; P = 0·007) than among those without (relative risk = 0·8; P = 0·2).

Table 4 also suggests an interaction between prostatic hypertrophy and varicose veins. A cross tabulation showed that prostatic hypertrophy was significantly associated with hernia in the absence of varicose veins (relative risk = 1·7 and P = 0·01, age adjusted) but not when varicose veins were present (relative risk = 0·8). Similarly, the association between varicose veins and hernia was apparent in the absence of prostatic hypertrophy (relative risk = 2·0, P = 0·00001) but not in its presence (relative risk = 1·0). The age-standardised rate of hernia was 22% when both varicose veins and prostatic hypertrophy were absent, 35% when only the former was present, 32% when only the latter, and 33% when both were present.

When the presence of an 'obvious' hernia, rather than of any hernia, was the dependent variable in the analysis of variance (Table 4, right-hand section),

Table 4 *Relationships between inguinal hernia and age, varicose veins, relative weight, prostatic hypertrophy, and haemorrhoids. Analysis of variance**

	Any inguinal hernia			*'Obvious' inguinal hernia†*		
Main effects	*Rate (%)*	*Beta*	P	*Rate (%)*	*Beta*	P
Age (years)		0·17	0·00001		0·25	0·00001
25-34	16			6		
35-44	21			12		
45-54	28			21		
55-64	33			27		
65-74	35			30		
75+	38			38		
Varicose veins		0·09	0·0005		0·10	0·003
Absent	23			15		
Present	33			25		
Relative weight		0·07	0·02		0·05	0·2
<100%	27			17		
100-119%	25			17		
120%+	18			13		
Probable prostatic hypertrophy		0·05	0·07		0·03	0·3
Absent	23			16		
Present	30			19		
Reported haemorrhoids		0·04	0·07		0·02	0·5
Absent	23			16		
Present	27			17		
Two-way interactions						
Haemorrhoids and relative weight			0·01			0·06
Prostatic hypertrophy and varicose veins			0·07			0·2
Other specific interactions			0·2-0·8			0·2-0·9
		Multiple R^2 = 0·06			Multiple R^2 = 0·09	

*The data for each factor are adjusted for effects connected with all four other factors (see page 60). The rates are lifetime prevalence rates of hernia, adjusted according to multiple classification analysis. The beta values are standardised partial regression coefficients.
†Men with palpable impulses only were excluded from this analysis. They appear neither in the numerators nor in the denominators of the adjusted rates.

Table 5 *Lifetime prevalence* of reported hernia, by age*

	Age (years)					
	25-34	*35-44*	*45-54*	*55-64*	*65+*	*Total*
No. of men (100%)	702	485	323	355	221	2086
Unoperated hernia (%)	3·1	4·9	4·6	5·9	12·7	5·3
Operated hernia (%)	4·0	6·8	13·3	16·9	22·6	10·3
Total hernia (%)	7·1	11·7	17·9	22·8	35·3	15·6

*Number of men with reported hernia, per 100 men of specified age.

highly significant associations were shown with age and varicose veins but the associations with relative weight, prostatic hypertrophy, and haemorrhoids were very far from significant. In all, the five variables accounted for 9% of the variance.

Among men who had been operated on for hernia, no significant associations independent of age were found between evidence of recurrence and physical activity at work, overweight, chronic bronchitis, constipation, or any of the other disorders or characteristics mentioned above.

Reported hernia

The lifetime prevalence of any hernia taken from the interview data is shown in Table 5. The rate rose from 7% at ages 25-34 to 35% at 65 or over.

Hernias were reported by only half of the men with clinical evidence of inguinal hernias. The reporting rate was lowest among men with palpable impulses only, 11% of whom reported that they had hernias. Hernias were reported by 54% of the men with unoperated swellings and 87% of those with operated hernias (Table 6). Of 112 men who reported an unoperated hernia, 36% were found to have inguinal swellings, 20% had palpable impulses only, 4% had operated inguinal hernias, and 40% had no clinical evidence of inguinal hernia.

Statistical indices of the concordance between the interview data and clinical findings are shown in Table 7. Because of the high false negative rate and the relatively low rate of positive reports

Table 6 *Reports of hernia* compared with examination findings†*

Examination findings	*No. of men (100%)*	*Percentage with reports of hernia*
Hernia‡		
Repaired	207	87
Unoperated swelling	85	54
Palpable impulse	215	11
Total	507	50
No hernia	1372	5

*Reported hernia at any site, including operated hernias.
†Inguinal hernia, including operated hernias.
‡Mutually exclusive categories, in descending priority.

Table 7 *Concordance between interview data* and examination findings† by age*

Index of concordance‡	*Age (years)*					
	25-34	*35-44*	*45-54*	*55-64*	*65+*	*Total*
Criterion: presence of any hernia						
False negative rate (%)	70	62	37	44	30	50
False positive rate (%)	4	5	2	5	11	5
Ratio of prevalence on examination to reported prevalence	1·9:1	1·7:1	1·5:1	1·5:1	1·2:1	1·5:1
Kappa	0·3	0·4	0·7	0·6	0·6	0·5
Criterion: presence of 'obvious' hernia						
False negative rate (%)	20	33	11	27	21	22
False positive rate (%)	4	6	4	6	13	5
Ratio of prevalence on examination to reported prevalence	0·6:1	0·8:1	0·9:1	1·1:1	0·9:1	0·9:1
Kappa	0·6	0·6	0·8	0·7	0·6	0·7

*Reported hernia at any site, including operated hernias.
†Inguinal hernia, including operated hernias.
‡False negative rate = percentage of negative reports, among men found to have hernias. False positive rate = percentage of positive reports, among persons not found to have inguinal hernias. Kappa is an index of agreement which makes allowance for the contribution of chance agreement (Spitzer *et al.*, 1967); a value of 1 indicates complete agreement, and 0 indicates absence of agreement.

among men without inguinal hernias (5%), the prevalence of inguinal hernia on examination was 1·5 times the reported prevalence of any hernia. Using the presence of an 'obvious' inguinal hernia as the criterion, the false negative rate was 22%, and there was closer agreement between the clinical and reported prevalence rates (ratio = 0·9). The concordance between interview and examination data was better for those above the age of 45 than below this age because of fewer false negative reports. This age variation was slight when the presence of an 'obvious' hernia was used as the criterion.

The age-standardised prevalence of reported hernia among the men who were examined (16·0%) was almost identical with that in the total population of interviewed men (15·8%), suggesting that the examination findings were not significantly influenced by sampling bias caused by incomplete response for examination.

Discussion

PREVALENCE

A salient finding is the high prevalence of hernia. A quarter of the men aged 25 or over in this population were found to have or have had inguinal hernias. The findings in the higher age groups suggest that one man in every three, or possibly even one in every two, will develop an inguinal hernia if he lives long enough.

Prevalence rates reported in other populations (Table 8) show wide variations, even among men of the same age. Among British recruits in their fourth decade, for example, a rate of 1·6% was reported in the first world war (Zimmerman and Anson, 1967) and a rate of 11% in the second world war (Edwards, 1943). Such discrepancies, it has been pointed out, may be caused by differences in 'the thoroughness of the examinations' and in diagnostic criteria (Zimmerman and Anson, 1967). It should be noted that most of the rates shown in the table relate to all hernias, not to inguinal hernias only, but about 94% of all hernias among males are stated to be in the inguinal region (Zimmerman and Anson, 1967).

For comparative purposes, Table 8 also shows rates from the present study, matched for age as far as possible. Because of the importance of such a match, we used our data on males aged 15-24 in spite of the possible sample bias in this age group. Unless otherwise stated we show our 'current prevalence' rates, on the assumption that successfully repaired hernias were probably not taken into account in the other studies. In the absence of explicit descriptions of diagnostic methods and criteria, precise comparisons are impossible.

Most of the rates shown in the table are either fairly close to the rate of 'obvious' hernias in the Jerusalem study, or lie between the rates of 'obvious' and all inguinal hernias; one rate (for the island of Pemba) is higher than the rate for all hernias in Jerusalem. The rates among recruits in the United States and the United Kingdom in the second world war are not very far below those for all hernias in the Jerusalem study. While it is possible that there is a real variation in prevalence, it is not unlikely that the differences arise mainly from discrepancies in study methods. It cannot be concluded that the prevalence in our population is necessarily exceptionally high.

UNREPAIRED HERNIAS

No fewer than two-thirds of all the hernias found, and one-third of the 'obvious' ones, had not been operated upon. The prevalence of unrepaired hernias rose with age: 13% of all men aged 65-74 and 23% of those aged 75 or over had unoperated

Table 8 *Comparative data on prevalence of hernia among males (clinical findings)*

Population	*Rate %*	*Comparable findings in present study**		
		'Obvious' hernias (rate %)	*All hernias (rate %)*	*Age group*
Israel				
Males aged 17½-18 years: inguinal hernia among total cohort of males born in 1940 (Cohen and Efran, 1964)	0·8	1·0	12·4	15-19
United States of America				
Men examined in draft, first world war: all hernias among first million examined (Zimmerman and Anson, 1967)	2·0	1·4	11·8	20-29
Selective service registrants, second world war: all hernias among about three million men (Zimmerman and Anson, 1967):				
Total	8·0	1·4	11·8	20-29
Whites	8·3			
Negroes	5·4			
Railroad workers: all hernias detected in routine examinations of 7967 workers (Nilsson, 1937)				
Excluding operated hernias	4·7	5·4	16·0	20-64
Including operated hernias	9·5	10·6†	21·2†	20-64
Hunterdon County, New Jersey: probability sample				
All abdominal hernias (Trussell and Elinson, 1959)				
25-44 years (87 men)	5·3	2·6	13·2	25-44
45-64 years (115 men)	6·0	11·7	22·8	45-64
65+ years (75 men)	22·9	21·7	30·6	65+
United Kingdom				
Recruits, first world war: all hernias. Data published by Ministry of National Service (Zimmerman and Anson, 1967):				
18-30 years, London	0·6	1·4	11·8	20-29
30-40 years, London	1·6	2·5	12·5	30-39
40-50 years: London	2·4	5·2	15·5	40-49
Manchester	12·5			
14-41 years: South Scotland	3·6	1·9	12·2	20-39
London	1·7-5·6			
Recruits, second world war: inguinal hernia among 1300 men aged 35-6 years (Edwards, 1943)	11·0	5·0	14·9	35-39
Pemba (island off Zanzibar): inguinal hernia among 528 Africans and Arabs aged over 21 attending hospital (not for hernia) or accompanying patients (Yordanov and Stoyanov, 1969)	25·2	6·9	17·4	20+

*Current prevalence, unless otherwise stated.
†Lifetime prevalence.

Table 9 *Mean annual mortality from inguinal hernia and hernias at unspecified sites, by age. Jewish males, Israel 1971-75*

Age (years)	*Cause-of-death rate per 100 000 population*			*Proportional mortality per 1000 deaths*		
	*Inguinal hernia**	*Hernia at unspecified site†*	*Total*	*Inguinal hernia**	*Hernia at unspecified site†*	*Total*
0-4	0·6	0·1	0·7	1·0	0·2	1·2
5-44	0	0	0	0	0	0
45-54	0·3	0·1	0·4	0·5	0·2	0·7
55-64	0·3	0·5	0·8	0·2	0·3	0·5
65-74	4·8	0·8	5·6	1·2	0·2	1·3
75-84	13·0	8·1	21·1	1·3	0·8	2·2
85+	19·6	14·7	34·3	1·0	0·8	1·8

Unpublished data provided by the Central Bureau of Statistics.
**International Classification of Diseases* 550 and 552 (WHO, 1967).
†*International Classification of Diseases* 551·9 and 553·9 (WHO, 1967).

visible swellings. Unfortunately we did not question our subjects about discomfort or disability caused by their hernias, but it may be that in this country there are relatively few men with untreated hernias that cause appreciable discomfort.

In spite of the risk of acute complications, the large number of unrepaired hernias does not necessarily imply a need for intensive efforts to find and repair them. In order to estimate the life-saving potential of such efforts, we examined national data on mortality from inguinal hernia (Table 9). The figures show a higher mortality among older men; but even over the age of 75 only two in every 1000 deaths can be ascribed to inguinal hernia. At most, an average of fourteen deaths a year can be attributed to inguinal hernia among Jewish males in Israel; these include deaths from complications of surgery. It is clear that an increased herniorrhaphy rate could not save many lives.

AETIOLOGY

Summarising the present-day concept of the aetiology of inguinal hernia, Zimmerman and Anson (1967) stated: 'Hernia ... represents a disparity between the intra-abdominal pressure and the strength of the encompassing abdominal wall ...'.

Associations were found in this study with varicose veins, prostatic hypertrophy diagnosed from suggestive urinary symptoms, and haemorrhoids. The hernia rate was higher if varicose veins and/or prostatic hypertrophy were present; only among lean men was the rate raised when haemorrhoids were present.

These associations may reflect the role of increased abdominal pressure, which has links with all three conditions. Increased pressure is an obvious effect of the straining at micturition occasioned by prostatic hypertrophy, and may cause varicose veins and haemorrhoids. Prolonged increases in intra-abdominal pressure, it has been suggested, may damage the sapheno-femoral valve. When this valve is incompetent any transient increase in intra-abdominal pressure is readily transmitted to the superficial leg veins (Martin and Odling-Smee, 1976), and may contribute further to the development of varicosity. Increased intra-abdominal pressure due to various causes increases the pressure of blood in the haemorrhoidal vein plexus and is believed to be one of the causes of haemorrhoids. The high rate of both varicose veins and haemorrhoids in developed countries has been attributed to the consumption of refined foods, through the effects of straining at stool or the exertion of local pressure by the loaded bowel (Burkitt, 1972). It is not impossible that dietary practices may form part of a set of interrelated factors, the effects of which find expression in the associated occurrence not only of inguinal hernia and the disorders we have found to be related to it, but also of a wider 'community syndrome' (Kark, 1974) of these and other disorders.

Obesity is usually regarded as a contributory factor in the aetiology of inguinal hernia (Zimmerman and Anson, 1967). Our findings suggest that, on the contrary, it is a protective factor—the prevalence of hernia was lower among men who were 20% or more overweight, allowing for effects connected with age and the three disorders discussed above. Although this association was confirmed by other measures of obesity (Quetelet's index and skinfold thickness), the possibility cannot be excluded that it is an artefact, owing to difficulty in the detection of hernia in plumper subjects. This seems an unlikely explanation, however, since it cannot account for the interaction found between relative weight and haemorrhoids in their relationships with hernia. If fatter men are in fact less subject to hernia, this may possibly be owing to relative laxness and hence distensibility of their abdominal walls, permitting the easy accommodation of changes in pressure, or to hydrodynamic effects of intra-abdominal fat, which is fluid at body temperature, that may serve to absorb or diffuse increases in pressure.

When only 'obvious' hernias were considered—that is, when those manifested only as palpable impulses were excluded—the relationships with prostatic hypertrophy, haemorrhoids, and relative weight were weak. This suggests that congenital, traumatic, or other factors play a relatively large role as predisposing or precipitating causes of the bigger hiatus in the abdominal wall which presumably characterises these well-developed hernias, and through which relatively slight changes in abdominal tension may suffice to protrude abdominal contents. It must be stressed that both for hernias as a whole and for 'obvious' ones, the associations found in this study account for only a small part of the aetiology of the disorder, as shown by the multiple R^2 values in Table 4.

HERNIA REPORTED IN INTERVIEWS

The findings indicate that interview data on hernias have low validity because of under-reporting. Two validity checks in the US National Health Survey (National Center for Health Statistics, 1961, 1973) have also shown much under-reporting. In both, almost half the hernias recorded in medical records during the previous year were unreported on interview.

There was less under-reporting in our study than in a study in Baltimore (Commission on Chronic Illness, 1957), where positive reports were received from only 21% of men found to have hernias on clinical examination; this reporting rate was 38% for self-respondents and 15% when proxy informants in the household were used. The corresponding rate in our study was 50%, or 78% among men with 'obvious' hernias. In Baltimore clinical evaluation revealed 4·5 times the number of hernias reported in interviews. The corresponding ratio in our study was only 1·5, or 0·9 for 'obvious' hernias.

The number of hernias reported during interviews in our study was considerably higher than in the United States. According to the US National Health Survey (National Center for Health Statistics, 1960, 1973) the prevalence of hernias in 1957-59 among men aged 25 or over was 3·6% (unoperated hernias and those operated on in previous year).

This difference in rates may well be an artefact caused by a relatively high under-reporting rate in the US survey. In that survey, it should be noted, proxy informants were questioned whenever the man himself was not available at the time of the household interview.

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