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Housing and appendicitis in Anglesey

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Abstract

***Study objective*—The aim was to test the hypothesis that provision of household amenities such as domestic hot water systems and bathrooms changed hygiene which thereby triggered the epidemic of appendicitis in Anglesey after the second world war.**

***Design*—The study was a cross sectional survey with histories of housing and appendicectomy obtained from Anglesey residents by postal questionnaire. The main outcome measure was reported appendicectomy.**

***Setting*—Four general practices in Anglesey.**

***Subjects*—2531 men and women born during 1923–62 and randomly selected from age-sex registers. Overall response rate was 73·7%.**

***Main results*—Subjects born into households with amenities—piped water, hot water systems, and bathrooms had, if anything, a reduced risk of appendicectomy. However, those who subsequently moved to houses that lacked amenities were at significantly higher risk than people born into houses without amenities who later acquired them.**

***Conclusions*—Provision of household amenities was not the important trigger to the epidemic of appendicitis which occurred in Anglesey after the second world war. Rather, the trigger may have been reduction in domestic crowding caused by the falling birth rate. Findings among those who moved house support other evidence that after infancy household amenities protect against appendicitis and contributed to the fall in appendicitis rates in Anglesey after 1965.**

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A recent hypothesis suggests that the epidemics of appendicitis which have accompanied industrialisation in many parts of the world result from improvements in hygiene.[1] The hypothesis proposes that the disease is triggered by enteric infection during childhood and early adult life. When hygiene begins to improve in a community, levels of infection in infants fall. This reduces their immunity to infection at later ages when the appendix is most vulnerable, and appendicitis therefore increases. As hygiene continues to improve, however, exposure to these pathogenic infections is reduced further and appendicitis declines.

Better housing conditions contribute importantly to better hygiene. Better housing includes reduced crowding in the home and provision of household amenities such as domestic hot water systems. In Anglesey, North Wales, housing was modernised more slowly than in most areas of Britain.[2] At the time of the second world war only one third of the island's population had a piped water supply and houses were unusually small and overcrowded.[3 4] After the war piped water was introduced throughout the county and housing improved. In accord with the hygiene hypothesis an epidemic of appendicitis followed, occurring while appendicitis rates in other parts of Britain were falling.[2] This epidemic began to decline around 1965.

Individual susceptibility to appendicitis was studied in a national sample of 5362 people born in Britain in 1946,[5] at around the peak of the appendicitis epidemic. Those born in households with hot water systems and bathrooms had higher rates of appendicitis. The relative risk was 1·0 for those in households with a bathroom compared with 0·7 in those in households without. Those born in less crowded households, that is with fewer people per room, also had higher rates of appendicitis, but the differences were not statistically significant. This suggested that provision of domestic hot water systems and bathrooms, rather than reduction in domestic crowding, may have been the early change in the transition to "western" hygiene that caused appendicitis rates to rise in Britain. To test whether this explains the epidemic in Anglesey, we have surveyed Anglesey residents and related histories of appendicectomy to amenities in the home during childhood and early adult life.

Methods

We randomly selected a sample of 2531 Anglesey residents born during 1923–62 from the lists of four general practices. The practices were chosen to give a wide geographical coverage of the island and adequate representation of both urban and rural dwellers. Each subject was sent a postal questionnaire with a covering letter from his or her doctor. The questionnaire asked about the first three houses in which the subject had lived, including the place and dates of residence, and whether the house had a water tap, hot water system, separate bathroom, flush lavatory, or mains drainage. It also asked whether the person had had an appendicectomy, and if so at what age. Non-responders were sent reminders after two months. Where subjects reported that their appendix had been removed, we attempted to

verify the history by reference to their general practice records.

In our analysis we examined the risk of appendicectomy in relation to place of residence at birth and housing facilities both at birth and later in life. Statistical calculations were based on Cox's proportional hazards regression model with allowance where appropriate for time dependent covariates.[6] In effect the model estimated the risk of appendicectomy during each year of life up to age 30 years in relation to housing at the beginning of that year and at birth. These risk estimates were then collated to produce a summary estimate. The potential confounding effects of sex and period of birth were taken into account by stratification.

Table I Risk of appendicectomy before age 30 years in relation to household amenities at birth. Each risk factor was examined independently with allowanace for year of birth (in 10 year strata) and sex. A few subjects were unable to provide information about housing faclities at birth.

Risk factor	*No of subjects at risk*	*No of appendicectomies*	*Relative risk*	*95% Confidence interval*
Bathroom				
—no	1115	193	1	
—yes	734	114	0·9	0·7–1·1
Water tap				
—no	619	116	1	
—yes	1238	192	0·8	0·6–1·0
Hot water				
—no	1017	176	1	
—yes	818	130	0·9	0·7–1·2
Flush lavatory				
—no	768	138	1	
—yes	1080	170	0·9	0·7–1·1
Mains drainage				
—no	750	137	1	
—yes	1089	170	0·9	0·7–1·1

Table II Risk of appendicectomy before age 30 years in subjects born into families resident in Anglesey according to household amenities at birth.

Risk factor	*No of subjects at risk*	*No of appendicectomies*	*Relative risk*	*95% Confidence interval*
Bathroom				
—no	720	128	1	
—yes	206	24	0·6	0·4–1·0
Water tap				
—no	510	92	1	
—yes	419	60	0·8	0·6–1·2
Hot water				
—no	658	110	1	
—yes	266	41	1·0	0.7–1·5
Flush lavatory				
—no	591	104	1	
—yes	355	48	0·9	0·6–1·3
Mains drainage				
—no	601	108	1	
—yes	322	43	0·8	0·5–1·1

Table III Risk of appendicectomy before age 30 years in relation to household amenities at birth and subsequently. Each risk factor was examined independently with allowanace for year of birth (in 10 year strata) and sex.

Risk factor	*No of appendicectomies*	*Relative risk*	*95% Confidence interval*
Bathroom			
—lacking at birth, present later	62	1	
—present at birth, lacking later	10	2·2	1·1–4·3
Water tap			
—lacking at birth, present later	47	1	
—present at birth, lacking later	8	2·2	1·0–4·8
Hot water			
—lacking at birth, present later	56	1	
—present at birth, lacking later	3	1·0	0·3–3·3
Flush lavatory			
—lacking at birth, present later	49	1	
—present at birth, lacking later	9	2·2	1·1–4·6
Mains drainage			
—lacking at birth, present later	37	1	
—present at birth, lacking later	10	1·7	0·9–3·4

Results

Usable questionnaires were returned by 898 men and 968 women, an overall response rate of 73·7%. The main reasons for the incomplete response were refusal (501 subjects) and change of address (110).

Three hundred and ten subjects reported that they had had an appendicectomy before age 30 years. We were able to confirm the history in 144 out of 158 of these cases. General practice records for the remainder did not cover the period during which the operation was reported to have taken place. In 87% of confirmed cases, the year of operation as reported in the questionnaire agreed to within two years with that recorded in the notes. Histology was recorded for 97 excised appendices and indicated inflammation in 33 out of 43 men and 28 out of 54 women.

Table I shows the overall risk of appendicectomy before age 30 years according to housing facilities at birth. Subjects born into households with amenities had a marginally lower risk of appendicectomy than those without, but the differences in risk were not statistically significant. A similar pattern was apparent when the analysis was restricted to the subjects whose first house was in Anglesey (table II), although the reduction in risk associated with having a bathroom was rather more marked (relative risk = 0·6, 95% confidence interval 0·4–1·0).

Information about one or more housing facilities at the time of appendicectomy was available for 165 subjects (ie, those who had not moved house more than twice before the operation). Table III shows the risk of appendicectomy in those who had an amenity at birth but later did not, as compared with those who lacked an amenity at birth but then acquired it. Risks were greater than one for most of the amenities examined, and for three—bathroom, water tap, and flush lavatory—the association was statistically significant. To test the potential impact of inaccurate reporting on these findings, we recalculated the risk estimates with age at appendicectomy adjusted down by two years. The risk associated with losing access to hot water increased to 1·4, but otherwise the figures were virtually unaltered.

Discussion

Among people now living in Anglesey those born into houses with a bathroom and other amenities had, if anything, a lower risk of appendicectomy (tables I and II). This suggests that provision of amenities was not an important trigger to the epidemic of appendicitis in Anglesey. People born into houses with amenities who subsequently moved to houses that lacked them were at significantly higher risk than people born into houses without amenities who later acquired them (table III). This supports other findings that after infancy better hygiene protects against appendicitis. A protective effect of household amenities was shown in two national samples of

people born in Britain during 1958 and 1970 (when appendicitis rates were falling).[5] The wider provision of piped water and associated amenities may have contributed importantly to the decline in appendicitis which began in Anglesey around 1965.

It seems unlikely that the observed pattern of risk was an artefact of the study method. Our review of general practice records indicates that recall of appendicectomy was reliable, and although some 30% of removed appendices are normal,[2 7] there is no reason to suspect that this proportion would vary markedly in relation to housing. We had no means of validating individual histories of housing in childhood, but the lower prevalence of amenities reported by people born in Anglesey is consistent with census data from 1931 and 1951.

The overall absence of risk in relation to household amenities at birth suggests that the rise in appendicitis in Angelsey was precipitated by some other development. Possibly the epidemic was triggered by reduced crowding in the home. Domestic crowding in Anglesey before the war was unusually severe, and was remarked on in national surveys.[4 8] Between the two censuses in 1931 and 1951 crowding levels fell sharply, presumably more in response to the falling birth rate than improved housing. Findings in the national sample of 5362 people born during 1946 suggest that provision of domestic hot water systems was more important than reduction in crowding in the transition to "western" hygiene which triggered the epidemic of appendicitis elsewhere in Britain.[5] These findings in Anglesey suggest that in conditions of more intense crowding, provision of amenities contributes relatively less to the onset of epidemics.

The hygiene hypothesis predicts that communities throughout the Third World will experience outbreaks of appendicitis when housing improves. It is important to examine further the extent to which different components of better housing determine the duration and severity of epidemics.

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