

Getting to the bottom of nappy rash

R PHILIPP

A HUGHES

J GOLDING

The ALSPAC Survey Team

SUMMARY

Background. Nappy rash accounts for 20% of dermatology consultations in childhood, but its causes are poorly understood.

Aim. To determine the incidence of nappy rash during the first four weeks of life in a geographically defined United Kingdom (UK) population, and to study the factors associated with developing the rash.

Method. The data are derived from self-completed questionnaires of parents in the Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC). The response rate to a questionnaire about the child administered four weeks after delivery among parents of singleton infants was 87% (12103/13902).

Results. The incidence of nappy rash was 25%. Fourteen highly significant possible causal factors emerged, of which 10 were retained in a logistic regression model: dirtying of nappy, contact with doctor about other problems, history of rashes in joints or skin creases, type of nappy worn, being fed cereal, taken to mother's bed when waking at night, history of cradle cap, general state of health, previous stomach upset, and being only breast-fed. However, the relative risks were generally small.

Conclusions. The likelihood of nappy rash increases with inter-current illness and early introduction of cereals. Disposable nappies give little protection, and this finding helps to endorse a recently introduced hospital scheme arising from environmental concerns that encourages parents to use cotton nappies instead of disposables. For many babies, however, the causes of nappy rash remain unknown.

Keywords: nappy rash; dermatology; causal factors; epidemiology.

Introduction

NAPPY rash is a general definition used to describe a range of inflammatory reactions of the skin in the area covered by the nappy.¹ Although not life-threatening, it is common and a source of concern for parents. This concern generates contact with general practitioners (GPs) and health visitors, who may advise diet manipulation, extra care including the costs of proprietary medicines, and changes in the types of nappies used.² The aetiology is disputed,³⁻⁵ and a diagnosis of nappy rash encompasses several different diseases. It is often said to be associated with irritation or chafing by the nappy and *Candida* infection of the infant,³ and with prolonged contact with faeces or urine, detergents, and dis-

infectants.⁶

In a Japanese study, mothers associated the following factors as having the greatest effect on provoking nappy rash in order of decreasing likelihood: delayed changing of nappies after evacuation, decreased frequency of bathing because of common cold, less frequent nappy changes, disposable nappies, many humid and damp days in the rainy season, common cold, insufficient rinsing of nappies, exacerbation of eczema, nappy cover made of synthetic fibre, changed detergents for nappy washing, cloth nappies and friction caused by new cloth nappies.⁶ In the United States (US), the prevalence of nappy rash has also been associated with maturity of the infant, bottle formula feeding, intestinal carriage of *Candida albicans*, and the frequency and duration of contact between infant skin and excreta.^{2,7}

Skin wetness, skin damage from faecal protease and lipase enzymes, and increase in pH from ammonia production when faeces mix with urine are additional factors presumed to cause nappy rash.⁸ In the 1980s, the structure of disposable nappies was improved by incorporating hydrogel superabsorbent materials that can physically trap urine and hold it within the absorbent matrix.¹ This helps to avoid contact between urine and faeces and thereby inhibits the activation of irritant faecal enzymes.⁹ These functions, it has been reasoned, make it possible to reduce the incidence of nappy rash by maintaining the local skin pH and wetness the same as elsewhere in the body.¹ Exclusive use of disposable nappies has been correlated with lower prevalence of nappy rash than when cloth nappies are sometimes or always used.^{2,7}

The occurrence of nappy rash is thought to vary with local standards of hygiene, types of nappy used, climate, season of the year, and age of the infant.³ However, only limited incidence and prevalence data are available. In the US, a study revealed that 75% of parents had reported a rash in the preceding two months, the frequency of a moderate rash reached a maximum at age 9–12 months, and no differences in prevalence were found between the sexes or racial groups.⁷ In Japan, 87% had experienced nappy rash.⁶ In Italy, 15% had experienced nappy rash, and infants aged 3–6 months were identified as being most at risk.¹ In the UK, nappy rash accounts for 20% of dermatology consultations in childhood.¹⁰ It is also generally assumed that all children develop at least one episode of nappy rash at some time during infancy.³ The present study was therefore undertaken to determine the incidence of nappy rash during the first four weeks of life in a geographically defined UK population, and to study the relative risks of contracting nappy rash for different factors associated with it.

Method

The ALSPAC was developed as an in-depth prospective study of children and parents, starting in pregnancy and monitoring health and development from fetal life through infancy into childhood and the early school years.¹¹ To be eligible for the study, mothers had to be resident in the county of Avon while pregnant, and their expected date of delivery had to lie between 1 April 1991 and 31 December 1992 inclusive. Information was collected retrospectively using self-completed questionnaires answered by the parents at the end of the first four weeks of life for all infants delivered during the study period. In the questionnaire, mothers were asked of their infant, 'Has he/she had a nappy rash' and

R Philipp, MSc, FFPHM, FFOM, consultant senior lecturer in public health medicine and occupational medicine, and A Hughes, MSc, MPhil, MFPHM, senior lecturer in medical statistics, Department of Social Medicine, University of Bristol. J Golding, MA, PhD, DSc, professor of paediatric and perinatal epidemiology, and the ALSPAC Survey Team, Institute of Child Health, University of Bristol.
Submitted: 25 March 1996; accepted: 11 March 1997.

© British Journal of General Practice, 1997, 47, 493-497.

'how bad was this: "very bad", "quite bad", "mild", "no problem"?'

There were 14 893 pregnancies enrolled in the study. Of these, 718 pregnancies had not survived until 20 weeks of gestation, and a further 104 mothers had either a late fetal death or a baby that died in the first month. The questionnaire sent at four weeks was child based. Thus, mothers with twins received two questionnaires. In all, 12 348 completed questionnaires were returned; a response rate of 87%. Those from multiple births, for which the baby management may be different from single births, and those with missing nappy data were excluded. Univariate analysis was undertaken on the remaining 12 103 cases for the following 24 factors that had been identified from the published literature as being possible causal factors for nappy rash: educational level of mother, ethnicity, sex, type of feeding, vitamin supplements, glucose and cereal in baby diet, waking at night, nappy changes at night, bedtime clothing, frequency of dirtying of nappy, stool consistency and colour, a history of stomach upsets, jaundice, sticky eyes, temperature, snuffles, cough, contact with GP, state of health, other rashes, cradle cap, and type of nappies worn.

The extremely large sample suggested that achieving statistical significance might be easy, but care would be needed to justify any clinical significance. Consequently, only variables with supporting evidence were considered, and the stringent cut-off of $P < 0.0001$ was used.

With the dependent variable of 'nappy rash', a stepwise logistic regression analysis was undertaken of those factors which, on univariate analysis, were highly significantly associated with nappy rash ($P < 0.0001$) and for which full data sets were available for a large majority of infants. Consequently, stool type and form were not considered further, and the logistic regression was run using 12 factors and based on data for 10 495 infants. The univariate analysis had established the support for some variables in explaining nappy rash, but there remained the question of the overlap/inter-relationship between many of these variables. Considering only these variables, logistic regression (using SPSS-PC) in stepwise mode would determine the most influential of the possible factors.

Results

In this study, and during the first four weeks of life, mothers reported that 25% (3084/12 103) of the babies had experienced nappy rash. The sex differences were marginal: 26.4% (1644/6238) of boys and 24.6% (1445/5865) of girls ($P < 0.05$).

Of the 24 factors for which univariate analysis was considered, highly significant ($P < 0.0001$) levels of association with nappy rash were reached for those variables reported in Table 1. Ethnicity, sex, vitamin supplements or glucose, nappy changes at night, bedtime clothing or a history of jaundice, sticky eyes, snuffles, cough or high temperature failed to reach the required P values.

From the 12 factors offered to the stepwise logistic regression, 10 were included ($P < 0.05$). The two non-significant variables were the mother's level of education and the sex of the baby. The results are shown as relative risks with confidence intervals (CIs) in Table 2. For each factor, the baseline category is defined as having a relative risk of 1.

It has been reported that parents are more likely than trained nurse graders to report 'slight' nappy rash, but as likely to report 'moderate' or 'severe' nappy rash.⁷ Accordingly, a separate analysis was also undertaken for 755 singleton infants in the study categorized by their mothers as having had 'very bad' or 'quite bad' nappy rash. For these cases, the mother's level of

education, the sex of the baby, type of nappy worn, being only breast-fed or being taken to mother's bed when waking at night did not reach highly significant ($P < 0.0001$) levels of association with nappy rash. The other 10 factors shown in Table 1 still reached this level of association. In the logistic regression, the type of nappy worn, being only breast-fed, having had cradle cap or being taken to the mother's bed at night did not reach statistical significance ($P < 0.05$). The other six factors shown in Table 2 remained significant.

Discussion

The incidence rate of 25% during the first four weeks of life is higher than expected, given that in the US the frequency of a moderate rash reaches a maximum at 9–12 months,⁷ and that in Italy an incidence rate of 15% during a 44-week study period has been reported.¹ The finding of the present study may be explained by self-reporting of symptoms by the mothers. It is unfortunate in this study that the large number of subjects and associated costs precluded objective assessment of the presence and severity of nappy rash. Nevertheless, the method has been shown to be very reliable and has a high validity for medical symptoms.¹¹ The findings for cases of only 'very bad' or 'quite bad' nappy rash are also generally similar to those for all cases. However, as shown in Table 1, the incidence of nappy rash increased with the mother's level of education, but this finding was not significant when mothers reported only 'very' or 'quite bad' nappy rash; if only these cases of nappy rash are included, the incidence rate is 6% (755/12 103). Similar incidence rates to those reported elsewhere^{1,2,7} were identified among boys and girls.

As shown in Table 2, the largest adjusted relative risk for having experienced nappy rash is 2.78 (CI = 1.14–6.76) and, quite plausibly, for a history of the baby 'sometimes being quite ill'. However, only 27 of the 12 103 babies were in this category, and the CIs of this relative risk are wide. The next largest relative risk is only 1.59 (CI = 1.49–1.70) for 'baby dirties nappy four or more times a day'. Many epidemiologists would, however, describe an odds ratio of 2 as 'strong'. Accordingly, the generally small relative risks identified in this study suggest that for many babies nappy rash in the first month of life is unlikely to have occurred as a direct result of any of the factors listed. The clinical significance of possible causal factors of nappy rash is better shown by the statistically significant findings for 'very bad' and 'quite bad' cases. For them, in addition to the baby 'sometimes being quite ill', an odds ratio greater than 2 with a CI lower limit of not less than 1 was also found for neonates seen by a doctor for other problems, being fed cereal in the first four weeks of life, and having had a stomach upset.

The association of nappy rash with frequent dirtying of the nappy is not surprising in such young infants. Furthermore, the finding of a significant relative risk for the baby 'sometimes being quite ill' is probably closely linked to the reported associations of nappy rash with diarrhoea and antibiotic therapy.^{1,12} Although the incidence and severity of nappy rash can be reduced with exclusive use of disposable nappies,^{2,7,8,13} the number of bowel movements per day decreases with maturity, as does urination frequency. As the infant ages, the skin in the nappy area is subjected to fewer insults from contact with faeces and urine. In turn, a reduced incidence of nappy rash arising from such contact can be expected.⁷ Yet, even during the first four weeks of life and as found in this study, compared with exclusive use of disposable nappies, the relative risk of nappy rash for babies with terry towelling nappies is only 1.16 (CI = 0.98–1.37). Furthermore, in the logistic regression among

Table 1. Univariate analysis of 14 factors associated with nappy rash ($P < 0.0001$).

Factor	Percentage of mothers reporting any nappy rash (severe* cases only)	Odds ratio (95% confidence interval)	Odds ratio (severe cases)
Baby dirties nappy			
Once or less per day	19 (1)		
Two to three times per day	25 (6)	2.18 (1.92–2.49)	1.22 (1.01–1.48)
Four or more times per day	34 (8)	3.43 (3.00–3.92)	1.78 (1.46–2.16)
Ever seen by doctor about other problems			
No	23 (4)		
Yes	31 (11)	1.53 (1.40–1.66)	2.72 (2.34–3.16)
Has liquid stools			
Never	22 (5)		
Occasionally	28 (8)	1.37 (1.17–1.59)	1.85 (1.42–2.41)
Sometimes	31 (8)	1.63 (1.43–1.86)	1.80 (1.42–2.27)
Always	28 (6)	1.41 (1.24–1.61)	1.37 (1.08–1.75)
Has green stools			
Never	23 (5)		
Occasionally	30 (8)	1.46 (1.29–1.65)	1.52 (1.21–1.91)
Sometimes	31 (8)	1.53 (1.35–1.74)	1.58 (1.26–1.98)
Always	26 (8)	1.21 (0.98–1.50)	1.51 (1.05–2.17)
Has had rash in joints/creases			
No	25 (6)		
Yes	36 (10)	1.69 (1.45–1.97)	1.85 (1.45–2.36)
Type of nappy			
Always disposable	25 (6)		
Mixture of types	33 (7)	1.50 (1.26–1.78)	1.21 (0.88–1.65)
Always terry towel	34 (9)	1.57 (1.27–1.95)	1.49 (1.04–2.14)
Has had cradle cap			
No	25 (6)		
Yes	31 (9)	1.37 (1.23–1.53)	1.57 (1.31–1.88)
Breastfeeding only			
Yes	27 (6)		
No	22 (6)	0.75 (0.68–0.83)	0.98 (0.82–1.17)
Taken to mother's bed when wakes at night			
Never	23 (6)		
Sometimes	27 (6)	1.26 (1.14–1.39)	1.04 (0.87–1.24)
Usually	29 (7)	1.37 (1.19–1.59)	1.30 (1.00–1.68)
Always	28 (7)	1.31 (1.16–1.49)	1.26 (1.01–1.58)
Mother's level of education			
CSE/vocational	23 (7)		
O level	24 (6)	1.04 (0.94–1.17)	0.91 (0.76–1.11)
A level	27 (6)	1.19 (1.05–1.34)	0.90 (0.73–1.12)
Degree or similar	30 (6)	1.44 (1.26–1.65)	0.83 (0.64–1.08)
Has been fed cereal			
No	25 (6)		
Yes	36 (15)	1.65 (1.35–2.01)	2.71 (2.05–3.58)
General state of health			
Very healthy	25 (5)		
Healthy	30 (9)	1.29 (1.17–1.43)	1.74 (1.47–2.06)
Sometimes quite ill	44 (30)	2.46 (1.15–5.27)	7.38 (3.21–16.93)
Almost always unwell	29 (14)	1.23 (0.39–3.93)	2.92 (0.65–13.08)
Has brown stools			
Never	25 (6)		
Occasionally	31 (9)	1.35 (1.10–1.67)	1.59 (1.12–2.25)
Sometimes	34 (10)	1.52 (1.28–1.80)	1.90 (1.45–2.50)
Always	26 (7)	1.06 (0.80–1.39)	1.28 (0.80–2.05)
Has had stomach upset			
No	25 (6)		
Yes	35 (14)	1.61 (1.30–1.99)	2.53 (1.87–3.42)

*Defined by mothers as 'very bad' or 'quite bad'.

Table 2. Adjusted relative risks and CIs of the factors significantly associated with nappy rash.

Factor	Relative risk	95% confidence intervals	Improvement chi-square
Baby dirties nappy			
Once or less per day	1.00*		225.9
Two to three times per day	0.94	0.89–1.01	
Four or more times per day	1.59	1.49–1.70	
Ever seen by doctor about other problems			
No	1.00*		83.1
Yes	1.20	1.14–1.26	
Has had rash in joints/creases			
No	1.00*		28.0
Yes	1.23	1.13–1.34	
Type of nappy			
Always disposable	1.00*		30.1
Mixture of types	1.14	1.00–1.31	
Always terry towel	1.16	0.98–1.37	
Has been fed cereal			
No	1.00*		20.2
Yes	1.29	1.14–1.46	
Taken to mother's bed when wakes at night			
Never	1.00*		24.2
Sometimes	1.03	0.96–1.11	
Usually	1.13	1.01–1.26	
Always	1.02	0.92–1.11	
Has had cradle cap			
No	1.00*		14.6
Yes	1.12	1.05–1.19	
General state of health			
Very healthy	1.00*		18.9
Healthy	0.80	0.50–1.29	
Sometimes quite ill	2.78	1.14–6.76	
Almost always unwell	0.67	0.21–2.14	
Has had stomach upset			
No	1.00*		9.5
Yes	1.22	1.08–1.38	
Breastfeeding only			
Yes	1.00*		4.0
No	0.94	0.88–1.00	

*Reference value.

infants with 'very bad' or 'quite bad' nappy rash, the type of nappy worn did not emerge as a significant factor. Therefore, and contrary to widespread belief, disposable nappies seem to have little protective effect. This finding may help to endorse a scheme recently introduced at the Leicestershire Royal Infirmary to encourage parents to use cotton nappies instead of disposables; it follows environmental concerns about the 50 million nappies dumped annually on Leicestershire's landfill sites, at an estimated cost to the county of £100 000.¹⁴

In contrast to the findings of other studies among older infants,^{2,7,15} the incidence of nappy rash during the first four weeks of life was more common among breast-fed rather than among bottle-fed babies (27% versus 22%, $P < 0.0001$). This finding may be explained by the lower pH of the faeces of breast-fed infants compared with those of formula-fed infants, and because the fermentative gut microflora of breast-fed infants produce more acidic metabolic waste products.¹⁵ The faeces of breast-fed infants are also lower in protease, lipase, and urease activities.¹⁵

However, as shown in Table 2, the association is weak and not identified in the logistic regression among babies with 'very bad' or 'quite bad' nappy rash.

It has been suggested that, during the first 12 months of life, the change from breast milk to formula or other foods may tend to increase the likelihood of nappy rash, and that controlled studies are required for the factors of rash and maturity.⁷ In the present study, the relative risk in Table 2 of 1.29 (CI = 1.14–1.46) for infants fed on cereals is supported by a relative risk of 1.64 (CI = 1.38–1.96) among infants whose mothers reported only 'very bad' or 'quite bad' nappy rash. This finding needs further study, as it differs from that of a recent Scottish study in which the incidence of nappy rash was not related to the early introduction of solids.¹⁶

The most important criteria in identifying causal factors are the biological plausibility of the evidence as well as strength and consistency between studies.¹⁷ Accordingly, and although several biologically plausible associations of nappy rash have been well

described, there are differences in methodologies and inconsistencies in findings between published studies. The generally small relative risks identified in this study suggest that the underlying causal factors for many cases of nappy rash remain unknown. Nevertheless, disposable nappies give little protection for babies up to four weeks of age, some of them are given cereals, the rash creates anxiety for parents, and it generates treatment costs. Further studies therefore seem justified in efforts to reach the bottom of this common problem. From this study and with extended data links, parental age, birth order of the child, concurrent reporting of other illnesses, and objective clinical assessment of the different rashes are factors that warrant attention.

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Acknowledgements

We are extremely grateful to all the mothers who took part, to the midwives for their cooperation, and to Dr Clive Archer, Dermatologist, who helped design the questions on rashes. The whole ALSPAC team continue to make the study possible. It could not have been undertaken without the financial support of the Department of Health, the Department of the Environment, British Gas and the University of Bristol. The ALSPAC study is part of the WHO-initiated European Longitudinal Study of Pregnancy and Childhood.

Address for correspondence

Dr R Philipp, Centre for Health in Employment and the Environment, Department of Occupational Health and Safety, Bristol Royal Infirmary, Bristol BS2 8HW.