

Prevalence and risk factors of neurological disability and impairment in children living in rural Kenya

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Accepted 30 January 2006

Background There is little data on the burden of neurological impairment (NI) in developing countries, particularly in children of Africa.

Methods We conducted a survey of NI in children aged 6–9 years in a rural district of Kenya. First, we screened for neurological disability by administering the Ten Questions Questionnaire (TQQ) to parents/guardians of children in a defined population. In phase two, we performed a comprehensive clinical and psychological assessment on children who tested positive on TQQ and on a similar number of children who tested negative.

Results A total of 10 218 children were screened, of whom 955 (9.3%) were positive on TQQ. Of these, 810 (84.8%) were assessed, and of those who tested negative 766 (8.3%) were assessed. The prevalence for moderate/severe NI was 61/1000 [95% confidence interval (95% CI) 48–74]. The most common domains affected were epilepsy (41/1000), cognition (31/1000), and hearing (14/1000). Motor (5/1000) and vision (2/1000) impairments were less common. Of the neurologically impaired children ($n = 251$), 56 (22%) had more than one impairment. Neonatal insults were found to have a significant association with moderate/severe NI in both the univariate [odds ratio (OR) = 1.70; 95% CI 1.12–2.47] and multivariate analyses (OR = 1.30; 95% CI 1.09–1.65).

Conclusions There is a considerable burden of moderate/severe NI in this area of rural Kenya, with epilepsy, cognition, and hearing being the most common domains affected. Neonatal insults were identified as an important risk factor.

Keywords Prevalence, risk factors, neurological impairment, children

Introduction

Neurological impairment (NI) is an important cause of disability and death. It is estimated to account for >28% of years lived with disability and to be responsible for at least one in every nine deaths.¹ It has been suggested that 85% of children with disability live in resource poor countries (RPCs),² but there is little data to support this.

Studies estimating the burden of NI in developing countries have been hampered by lack of relevant medical records and registries. In places where these sources of data are available,

they are often of insufficient quality to estimate the burden accurately. The Ten Questions Questionnaire (TQQ)³ has been developed to screen for neurological disability in children in resource poor settings. The tool consists of 10 questions in a yes/no format and has been validated in studies in Bangladesh,⁴ Jamaica,⁵ Pakistan,⁶ and, more recently, in Kenya.⁷

We measured the prevalence and investigated the risk factors for NI in older children living in a rural area in Africa, and compared our data with data from other studies in Africa and other continents.

Methods

Study setting

This study was conducted in a demarcated area in Kilifi District, one of the poorest areas in Kenya,⁸ that is mainly inhabited by

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subsistence farmers. The formal health care system comprises a government hospital, five government dispensaries and 15 private clinics. The neonatal and under-five mortality in this area are 41 and 141 per 1000,⁹ respectively. The study area was sub-divided into 87 enumeration zones, with sketch maps of each zone drawn in 1992 and recently updated, showing major landmarks, footpaths, and the relative positions and survey numbers of each homestead.⁷ The sketch maps were used to locate each household during a census in October 2000, and the survey was conducted by us from June 2001 to March 2002.

Population

The study population consisted of children aged 6–9 years identified from a census of 108 896 people. The population consists mainly of the Mijikenda ethnic group, in which the Giriama sub-group predominates. Children aged 6–9 years were selected because of difficulties in identifying NI in children younger than 6 years (particularly assessing hearing and vision) and the lack of culturally appropriate assessment tools for cognition in young children from this area. Furthermore, since one of the aims of this study was to identify acquired NI, whose most likely causes are infections (bacterial meningitis and cerebral malaria) and which commonly occur post-natally (neonatal insults and those after the neonatal period) until age 5, it was appropriate to study children in this age group. Only children who had been residing in the area for at least 6 months prior to the survey were included.

In this study, we defined NI as any disorder resulting from damage to the nervous system or the brain, and neurological disability as the inability (due to Neurological Impairment) to perform an activity in a manner or range considered normal for an individual. The TQQ is administered to the parents or guardians of children and detects disability as perceived by these adults. The assessments measure impairment in the following domains: cognition, motor, hearing, vision, and epilepsy.

Study design

This study consisted of two stages. In Stage 1, the TQQ was administered to the parents or guardians of children aged 6–9 years. In Stage 2, clinicians and psychological assessors assessed children with at least one positive response on TQQ. A similar number of children from those who tested negative were also invited for assessment (we chose one in every 12 children as this was the prevalence of disability in our pilot survey and was similar to that observed in other studies of NI^{4–6} and would be expected to give us broadly similar numbers of affected and unaffected children. All these children underwent comprehensive clinical and psychological assessments at the research centre, to detect epilepsy and impairments of vision, hearing, motor function, and cognition. The assessments were performed within 1 week of the screening. None of the clinicians or assessors involved in the study was aware of the result of the TQQ screen at the time of the examination.

TQQ screening instrument

The TQQ was developed for identifying children with disability in RPCs and utilizes non-professionals in its execution. It is a

short questionnaire in a yes/no format and consists of 10 questions, one question each addressing the child's vision, hearing, motor skills, and seizures, six concerning cognitive development, and one extra question regarding other serious health problems.³ It is designed to detect moderate to severe disability and impairment but not the mild ones. Previous studies have shown it to be useful in the detection of severe and moderate cognitive, motor and seizure impairment, and poor in the detection of vision and hearing, and mild impairment.^{4–7} The questionnaire was translated into Kigiriama and back to English to ensure the intended meaning remained the same, before being piloted.

Household screening

Five trained field interviewers fluent in Kigiriama performed the household screening after undergoing a week's training in field methods and administration of the questionnaire used in the survey.⁷ The field interviewers administered the TQQ to the parents or guardians of 80–100 children daily.

Psychological and neurological assessment

A team of three clinicians and five psychological assessors performed the assessments. The assessments included vision (Sonksen-Silver Acuity system),¹⁰ hearing (Kamplex screening audiometer),¹¹ and motor impairments (clinical examination). The diagnosis of epilepsy was based upon the history. Local adaptations of assessments of cognitive abilities, speech, and language were used. The cognitive assessment involved a seven-item battery testing verbal and non-verbal skills, which included: 'panga mutu' ('build a man', testing intellectual and developmental maturity of a child through observing how a child deploys a set of basic skills to represent their knowledge of the human form)¹²; a local adaptation of the matching familiar figures (assessing information processing speed and impulsivity)¹³; digit span (auditory short-term memory)¹⁴; a construction task using wooden sticks (simultaneous processing, visual-motor co-ordination, visual-spatial perception and reasoning)¹⁵; category fluency (retrieval from long-term memory)¹⁴; information questions¹⁵ and a picture vocabulary test (receptive vocabulary, verbal comprehension, achievement and association of pictures and words).¹⁵ The speech and language assessment battery included measures of comprehension, expression, and the child's phonological system.¹⁶ The neurological assessment included a detailed medical history, treatment, and family history. A full clinical and neurological examination was performed. For the definition of impaired cognition, Z-scores for each of the tasks in the battery were calculated initially for each age band (6 through 9 years of age) on a sample representative of the overall population in their screening status (positive or negative). The means and standard deviations were then calculated from this sample. Z-scores were then calculated for each age band on all children who had been tested and these scores were used to determine impairment and level of severity (Table 1). The Z-scores used are based on the age-banded scores of at least 360 children in each age band. For other domains, the definition of severity was based on the criteria developed by the World Health Organization (Table 1).¹⁷

Table 1 Definitions of moderate and severe impairment

Impairment	Moderate	Severe
Cognitive	Z-score of below -2 on two or more of the seven tests OR mean Z-score for all tasks below -2 for a child who had performed construction task and a non-verbal task but not the key verbal tasks (picture vocabulary and information questions tasks) OR the mean Z-score for verbal tasks was below -2 .	Z-score below -3 on two or more of the seven tests OR mean Z-score below -3 for a child who had performed construction task and a non-verbal task but not the key verbal tasks (picture vocabulary and information questions tasks) OR the mean Z-score for verbal tasks was below -3 .
Motor ^a	Difficulty in holding implements, dressing and sitting upright. Able to move around with help.	Inability to walk and absence of functional use of hands.
Epilepsy ^a	More than one non-febrile seizure per month.	More than one non-febrile seizure per week.
Hearing ^a	A 41–70 dB loss in the best ear and difficulty in hearing even with a hearing aid.	More than 70 dB loss in the best ear, no useful hearing.
Vision ^a	Vision loss of 6/18 m.	Visual acuity worse than 6/60 metres, only light perception.

^a Adopted from WHO procedure manual.

Details of previous admissions

The children's detailed medical history, which included information on whether the child had been admitted to Kilifi District Hospital (KDH), was used to track hospital records to determine the causes of admission for these children.

Potential risk factors for NI

Information was collected on numerous potential risk factors for NI by parent report using structured questionnaires during the medical assessments. For this analysis, 25 variables were selected as potential risk factors for NI. We have categorized these into socio-demographic factors and factors operating primarily during one of the three stages of fetal and child development: prenatal, perinatal, and post-natal. After the initial univariate analysis, 13 variables were identified as potential risk factors for the development of NI. For the purposes of this study, neonatal insult was defined by a positive history of birth asphyxia, tetanus, jaundice, or sepsis or any other potential NI causing infection during the neonatal period. The information was based on hospital and maternal/guardian report.

Data storage and analysis

All phase 1 and 2 data were double-entered and stored using Fox-pro software after verification of the data had been performed. Statistical analysis was performed with Stata version 8 (Stata Corporation, TX, USA). For the purpose of this study, NI was categorized depending on the domain affected: cognition, motor, epilepsy, hearing, and vision. Adjusted estimates of prevalence and its variance were computed using formulae that took account of the two-phase design of the study.¹⁸

Logistic regression analysis was used to investigate associations between potential risk factors and moderate/severe NI. Variables were entered into logistic regression models if the *P*-values associated with their regression coefficients were <0.25 ; they were retained if their respective *P*-values were <0.10 and/or their removal substantially affected the magnitude of the regression coefficients for other variables in the model. In the multivariate analysis, we used factors that fulfilled the statistical criteria $P < 0.10$ and controlled them for

child's age and schooling, since these have major effects on cognitive performance.

The National Ethics Committee of Kenya Medical Research Institute approved this study.

Results

A total of 10 218 out of 11 416 children aged 6–9 years resident in the study area were screened; of whom 50.5% were males. For the screened children, 29% were aged 6 years, 25% were aged 7 years, 23% were aged 8 years, and 23% were aged 9 years. Out of those screened, 955 (9.3%) were positive on TQQ (delayed milestones and hearing difficulties being the most common types of problems reported).⁷ Of those identified as positives, 810 (84.8%) were assessed in the second phase of the study. Assessment was not performed on 32 who did not consent; 36 who were under or over age on review of their date of birth; 38 who had moved out of the study area; and 39 who could not converse in the language of the cognitive tests. Eight hundred and sixty-one children who were negative on the TQQ were also invited for assessment, 89% (766) of whom were assessed. Assessment was not performed on 95 children who failed to attend after being invited.

In the sample of children assessed, 1324 (84%) of them were born at home. Seventy-eight per cent of these were births assisted by untrained birth attendants.

Prevalence

Two hundred and fifty-one children out of the total assessed were found to have NI with an adjusted prevalence of moderate/severe NI of 61/1000 [95% confidence interval (95% CI) 48–74] (Table 2). There were no significant differences in prevalence between boys and girls ($\chi^2 = 0.5$; $P = 0.5$) or within the age groups ($\chi^2 = 1.5$; $P = 0.2$). In addition, no significant geographical variations in prevalence were found within the study area.

The prevalence for specific impairments varied widely (Table 2), with epilepsy being the most common followed by cognitive and hearing impairments. Fifty-six children (22% of all children with impairment) were found to have one or more NIs. Seventeen of them (30.4%) had epilepsy with cognitive

Table 2 Estimated prevalence (adjusted^a) of moderate/severe impairment [per 1000 children (95% CI)]

Impairment	All children (95% CI)	Boys (95% CI)	Girls (95% CI)
Any impairment	61 (48–74)	52 (36–68)	79 (56–102)
Epilepsy	41 (31–51)	37 (24–49)	45 (30–59)
Cognitive	31 (22–41)	27 (15–39)	36 (21–51)
Hearing	14 (9–18)	12 (5–18)	15 (8–22)
Motor	5 (2–8)	5 (4–6)	4 (1–7)
Visual	2 (0–18)	2 (0–5)	2 (0–5)
Total	10218	5160	5058

^a Adjusted using the Shrout method.¹⁸

impairment, seven (13%) had cognitive with motor impairment, and six (10.8%) had hearing impairment with epilepsy. Forty-four (17.5%) of the children with NI had speech and language impairments.

Risk factors

In both the univariate [odds ratio (OR) 1.70; 95% CI 1.12–2.47] (Table 3) and multivariate NI (OR 1.30; 95% CI 1.09–1.65), neonatal insults were found to have a significant association with moderate/severe NI.

Causes of admission

Of the children with NI ($n = 251$), 130 (52%) were reported to have been admitted to hospital. We were able to confirm 73 admissions to KDH from the hospital database. Central nervous system infections ($n = 6$), neonatal sepsis ($n = 1$), neonatal jaundice ($n = 1$), and birth trauma ($n = 1$) were identified as potential causes of NI in these children. The other causes of admission included were non-severe malaria ($n = 30$), respiratory tract infections ($n = 19$), febrile convulsions ($n = 4$), and miscellaneous causes ($n = 11$).

In contrast, 280 children who tested negative on TQQ were reported to have been admitted to KDH. We were able to confirm 113 of them from the hospital database. Central nervous system infections ($n = 11$), neonatal sepsis ($n = 3$), neonatal jaundice ($n = 1$), and birth trauma ($n = 1$) were identified as potential causes of NI in these children. Other causes identified were non-severe malaria ($n = 30$), respiratory tract infections ($n = 29$), anaemia ($n = 10$), gastroenteritis ($n = 10$), febrile convulsions ($n = 5$), and miscellaneous causes ($n = 13$).

Discussion

This study identifies a significant burden of NI in a rural area of Africa, with 6% of older children having moderate or severe NI. Epilepsy, cognitive, and hearing are the domains most affected, and 22% of the children had multiple impairments. There were no significant differences in prevalence between boys and girls.

The prevalence of NI in this study is comparable with the estimate from South Africa¹⁹ but was considerably higher than those reported in Bangladesh, Pakistan, Jamaica, Saudi Arabia, and Ghana^{4–6,20,21} (Table 4). The differences may be explained

Table 3 Univariate analysis of risk factors for neurological impairment

Risk factors	Moderate/severe impairment	
	Odds ratios	95% CI
Risk factors		
Maternal age at child's birth >30 years	0.87	0.62–1.21
No maternal education	0.95	0.71–1.23
Mother not involved in economic activity	1.02	0.70–1.39
Partner not involved in economic activity	1.11	0.80–1.53
Age 6 years	0.98	0.72–1.32
Male children	0.90	0.70–1.20
Antenatal problems		
Lack of prenatal medical care	1.28	0.58–2.81
Perinatal problems		
Home birth	0.70	0.49–1.00
Traditional birth attendant	0.54	0.25–1.12
Untrained birth attendant	0.83	0.57–1.19
Birth difficulty	1.07	0.64–1.80
Post-natal problems		
Neonatal insults	1.70	1.12–2.46
Not immunized	0.68	0.39–1.19

by the use of different assessment tools or real differences in the prevalence. Since, the studies in Ghana,²¹ South Africa,¹⁹ and Saudi Arabia²⁰ did not assess a sample of children testing negative on TQQ, the sensitivities and specificities of the TQQ used in these studies are unknown. Furthermore as this study assessed children aged 6–9 years, it may not provide an estimate of the full burden of disability, since many children with severe impairments will have died before they reach this age. This may explain the low prevalence of cerebral palsy in this study.

The prevalence of cognitive impairment was similar to that in the South African study, but considerably higher than those reported in the other studies outlined in Table 4. These differences could be related to differences in definition and/or tools used in assessing cognition. It is important to note that for any broad psychological assessment, psychologists should be used to administer standardized tests when assessing cognition; however, absence of standardized tools and inadequate trained psychologists in our situation, forced us instead to use trained assessors and adapted tools that were culturally modified.

The high prevalence of epilepsy in this area may be attributed to the high prevalence of CNS infections, in particular severe falciparum malaria and acute bacterial meningitis in this area. It is well established that CNS infections, including severe falciparum malaria, can lead to epilepsy.^{22,23} The low prevalence of moderate/severe motor impairment can be attributed partly to the increased mortality of children with these impairments in this community. We have found that children with severe neurological deficits following severe malaria (mainly motor deficits) are at an increased risk of dying after discharge from hospital.²⁴

Table 4 A comparison of prevalence rates [per 1000 (95% CI)] in seven populations surveyed with the TQQ

Place	Year of study	Author	Unique Study Feature	Age	Urban or Rural population		Pop	Any NI	Cognitive	Motor	Epilepsy	Hearing	Vision
					Rural	Urban							
Kenya	2001–02	Mung'ala-Odera <i>et al.</i>	8.3% of the negatives used as controls	6–9	Rural	Rural	10 218	61 (48–74)	31 (22–41)	5 (2–8)	41 (31–51)	14 (9–18)	2 (0–18)
South Africa ^a	2001	Couper ¹⁹	Controls not used	6–9	Rural	Rural	2036	63	67	30	13	36	25
Ghana	2000	Biritwum <i>et al.</i> ²⁰	Controls not used and small sample size	6–9	Rural & Urban	Rural & Urban	594	17	–	–	–	–	–
Saudi Arabia ^a	1999	Milaaat <i>et al.</i> ²¹	Controls not used and included children up to 12 years	6–12	Urban	Urban	1550	37	–	–	–	–	–
Jamaica ^a	1987–88	Thorburn <i>et al.</i> ⁵	8.0% of the negatives used as controls	2–9	Urban	Urban	5468	25	19	2	0.4	4	0.8
Bangladesh	1987–88	Zaman <i>et al.</i> ⁴	10% of the negatives used as controls	6–9	Rural and Urban	Rural and Urban	5352	19 (10–29)	7 (2–11)	1 (0–2)	0.2 (0–0.6)	10 (3–17)	2 (0.8–3)
Pakistan	1987–88	Durkin <i>et al.</i> ⁶	8.0% of the negatives used as controls	2–9	Rural and Urban	Rural and Urban	6365	44 (36–52)	19.0 (13–24)	20 (14–25)	5.0 (3–7)	5.2 (3–7)	15 (10–20)

^a 95% Confidence limits not given.

It is worth noting that the prevalence rates reported in this study are minimum estimates since the TQQ only reliably detects moderate to severe disability and not the mild conditions. Furthermore since it depends upon the parental reporting, it has a low sensitivity in detecting vision and hearing impairment. However, the TQQ still remains a useful tool for identifying children with disability in RPCs in which records are either non-existent or poor quality.

The risk factors associated with moderate/severe NI were potential neonatal insults. Similar findings have been reported in studies in Nepal and Kenya, where it was found that neonatal encephalopathy²⁵ and tetanus²⁶ increased the risk of NIs among survivors. Although 130 (52%) of children with NI were reported by the parents/guardians to have been admitted to hospital, we could only confirm 73 of these admissions to KDH, the main government hospital that serves this area. Some of the children may have been admitted to private clinics or other clinics. In those children admitted to KDH, CNS infections and birth trauma were identified as potential causes of NI. However, these had no association with NI, possibly because of the small sample size. Other risk factors such as lack of prenatal care, birth difficulties, home births, lack of maternal education, and maternal age >30 years at birth of child, which have been identified in other studies as risk factors for NI, especially cognitive impairment,^{27–29} were not identified in this study. This may have been caused by poor recall of birth events by mothers. We have found that mothers who deliver at hospital often forget many of the events surrounding the delivery of the child 4 years later.³⁰

In addition, a selection bias caused by poor survivorship of infants born under these conditions may have resulted to an underestimation of neurologically impaired children in this community.

The significant burden of neuro-cognitive impairment in rural Africa is likely to increase, with the reduction in childhood mortality. However, there is need to establish the causes of NI in these areas, although prevention and aggressive treatment of neonatal insults would reduce the prevalence in this area. Furthermore, sustainable community-based rehabilitation services need to be instituted to support people with disabilities arising from this impairment.

Acknowledgements

The Wellcome Trust-UK and the Kenya Medical Research Institute supported this study. We thank the mapping and census team, field staff, and assessors who made this study possible. In particular we thank Joseph Gona, Godfrey Otieno, Elizabeth Obiero, Khamis Katana, Kenneth Rimba, Gladys Murira, Judy T Dzombo, Francis Yaa, Douglas Konde, Mary Karisa, Francis Kanyetta, Silas Haro, Karen Konde, and Janet Chea. We also thank Drs Penny Holding and Julie Carter for their assistance in the design and development of assessment tools; Tansy Edwards, Dr Neal Alexander and Dr Anthony Scott for their comments on the manuscript; and Prof Kevin Marsh and Dr Norbert Peshu for their advice on the study design. This paper is published with the permission of the director of KEMRI. C.R.J.C.N. holds a Wellcome Trust Career Post in Clinical Tropical Medicine (No. 050533).

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